DOCUMENT RESUME

ED 052 000 SE 010 153

TITLE	DISCUS Seventh Grade, Life Sciences, Part One.
INSTITUTION	Duval County School Board, Jacksonville, Fla. Project DISCUS.
PUB DATE	Sep 69
NOTE	180p.; Revised September 1, 1969
AVAILABLE FROM	DISCUS, 1011 Gilmore Street, Jacksonville, Florida 32204
EDRS PRICE	EDRS Price MF-$0.65 HC Not Available from EDRS.
DESCRIPTORS	*Biology, *Disadvantaged Youth, *Instructional Materials, Laboratory Procedures, Science Activities, *Secondary School Science, *Teaching Guides

ABSTRACT

Included are instructional materials designed for use with disadvantaged students who have a limited reading ability and poor command of English. The guide is the first volume of a two volume, one year program in life science and contains these three units and activities: Measurement, 7 activities; Ecology, 12 activities; and Energy Processes, 24 activities. A formal textbook is not used in this program, and the learning process relies on class discussion supported by audiovisual materials and small group laboratory activities. Each lesson has a suggested format for teachers to follow in directing activities, with suggested teacher comments. Following each teacher section is the printed material for student use, which generally includes a list of required equipment for small group activities, introduction and procedures, and fill-in questions relating to the completed activity. The volume begins with extensive "guidelines for creating an appropriate classroom environment." (PR)

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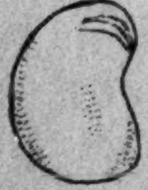
DISCUS SEVENTH GRADE



LIFE SCIENCES

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The DISCUS project has developed a course of study in science for the junior high grades (7-9). The material for each grade level has been bound into two manuals.

GRADE 7	BIOLOGICAL SCIENCE
GRADE 8	PHYSICAL SCIENCE
GRADE 9	EARTH SCIENCE

Your comments concerning these materials will be appreciated. For further information, contact the project director.

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Revised
9-1-69

DISCUS SEVENTH GRADE BIOLOGICAL

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I

GUIDELINES FOR CREATING AN APPROPRIATE CLASSROOM ENVIRONMENT FOR EDUCATIONALLY DISADVANTAGED YOUTH APPLIED IN AND SUPPORTED BY THE PROJECT

1. Assumptions Made Regarding Educationally Disadvantaged Youth

    a. Human ability is to a large extent a social product. It depends upon the opportunities in the environment for meaningful and varied experiences. In many areas it does not develop unless recognized and encouraged by society.

    b. Educationally deprived children have had a narrow range of experiences in a limited environment, hence have a lack of confidence in themselves in a classroom situation.

    c. The conceptual development and the cultural heritage of educationally deprived children is inferior to that of children in more favorable environments.

    d. Because of limited experiences, educationally deprived children are limited in their ability to communicate with others orally or by means of reading and writing.

    e. The child who grows up in a culture of poverty has a strong feeling of fatalism, helplessness, dependence, and inferiority in social situations.

    f. By the time educationally deprived children enter school they have absorbed the basic attitudes and values of their subculture of poverty. As a result they are not ready to take advantage of the educational opportunities in the school or of opportunities that may come as a result of changed conditions during their lifetime.

    g. Any significant change in the relative position of the educationally deprived child requires a preferential treatment that will compensate for his inadequacies. These children require modified teaching techniques and a specially constructed curriculum if they are to succeed in school. They need special materials and devices to fill the gaps in their experience.

h. The time of readiness to learn can be advanced and the quality of development can be enriched by working with educationally deprived children before they show overt signs of readiness.

i. Deprivation is largely due to failure of environmental agents:
    a. failure to provide children with necessary nourishment before they are ready to exercise specific capacities.
    b. failure to use and develop these capacities once they are ready for exercise.

j. Although the preschool years are characterized by the most rapid change and growth and so are the most important years, yet the adolescent years are also a period of rapid change and growth, hence, these years are fruitful ones for the re-orientation and development of educationally deprived children.

k. Wherever poverty exists throughout the world there is a remarkable similarity in the style of life which may be called a "culture of poverty". This culture provides the human beings living in it with a design for living that permits their survival. This similarity is found in the structure of families, in interpersonal relations, in value systems, in spending habits, and in their tendency to live in the present with little thought of the future. The high incidence of common law marriages and of households headed by women are characteristic of this culture wherever it occurs.

2. Guidelines Used to Determine Science Experiences for Educationally Disadvantaged Youth

    a. Classroom studies should be related to the students' contemporary experiences in their society. Certain aspects of historical development may be helpful, but a consideration of these for endorsement and clarification will come after the ideas are crystallized through concrete experiences.

b. A definite classroom situation must be provided in which new experiences with objects and events are related to past experiences in such a manner that new relationships are discovered. By associating several new experiences during a short period of time, an awareness of the basic principles that account for these experiences **may** be developed.

c. Science experiences must be developed from the common interests of the learners and result in an understanding of the basic principles of science that are related to these interests.

d. Initial learning of first level abstractions comes from observations of particular objects and events via all of the senses. First hand experiences should be emphasized.

e. There is a continuum in learning experiences that ranges from observation of particular objects and events, through those presented using multi-sensory aids, through the presentation of abstract concepts. Within the continuum of experiences, those located toward the concrete end are preferable.

f. Motivation for further learning will result from meaningful and enjoyable experiences with objects and events. Whenever possible "discovery" experiences should be planned for through "pre-eureka" procedures. Successful experiences in accounting for particular objects and events will provide motivation for additional experiences with other objects and events.

g. Audio-visual materials should be developed for use in initiating activities; for use in lieu of concrete experiences where these are impractical; and for use in providing additional enriching experiences.

h. The lack of communication skills and the lack of self-confidence make mandatory that educationally deprived children succeed in what they do. The tasks they undertake in school must be measured in difficulty and be ordered sequentially to guarantee success.

i. A wide range of materials together with opportunities to use these materials in meaningful ways must be provided if each educationally deprived child is to enhance his own self-confidence by noting his own growth in ideas and skills.

j. The major outcome of classroom experiences in science is to create in the educationally disadvantaged youth a desire to learn and a positive attitude toward school.

k. The school program should improve the basic skills of speaking and reading.

l. Culturally disadvantaged adolescents should be permitted to specialize in an area in which they are specially interested.

3. Guidelines Used to Determine How to Teach Science to Educationally Disadvantaged Youth.

a. The teacher must accurately assess the strengths, weaknesses, and interests of each child in order to counsel and guide each in his pursuit of knowledge.

b. Instruction will of necessity be largely with small groups rather than with the total class.

c. The teacher must know the content and the processes of science; the childrens' environment, their fears and concerns, and be skillful in guiding their learning experiences.

d. Educationally deprived adolescents will have had many frustrating experiences so special care must be taken to enable each to succeed in each task undertaken. This success should be used to reinforce and to motivate further learning.

e. The teacher must be willing for the child to deal primarily with specific objects, events, or persons as these objects, events or persons relate to himself, rather than to be concerned primarily with generalized activities.

f. The teacher as a discussion leader accepts every response as a contribution and by questions, suggestions, and vocabulary directs the development of the concept.

g. The teacher must be able to arrange a learning situation in which the youth's belief in himself, his self-image, escalates. Each must operate responsibly in a self-directed way to build a confident self-image.

h. The teacher should become an active partner with the pupils while maintaining an appropriate teacher image fostering abilities before, as well as during, the expected maturation time for these abilities.

i. Even though educationally deprived, each child will have had many experiences that may be used to promote learning.

j. The same concepts should be developed in several ways from a number of different but related experiences.

k. The major purpose of laboratory experiences is to promote creative thinking, not to manipulate equipment.

l. Reading materials should be selected to supplement the classroom actiities out of which basic principles have been developed. In this way the basic principles may be firmly fixed in mind and also skills and habits of reading may be taught.

m. Assignments should be short. Emphasis should be on quality of work rather than on quantity of work.

n. Vocabulary load should be kept at a minimum level. Special effort should be made to teach the required vocabulary.

o. Mathematical calculations should be kept at a minimum level so that measurements and quantitative treatment of results enhances rather than stifles learning.

p. Testing should be used primarily to promote learning. It should be situation centered and involve such skills as interpretations of data, application of principles, the formulation of appropriate hypotheses, as well as to enable the student to assess his comprehension.

4. Guidelines Used to Select Science Experiences For Educationally Disadvantaged Youth

   a. Selection of topics for individual, small group or class investigation must provide avenues that insure success. Therefore, the investigation must center around directed inquiry rather than unassisted discovery.

   b. Each illustrative and investigative activity should:

      a. relate to the pupils' common experiences
      b. lead to a better understanding of the pupils' invironment
      c. stem from and enhance the pupils' interest
      b. be specific rather than generalized, especially at the beginning.
      e. furnish a basic for improving language skills, especially reading and oral expression
      f. be of measured difficulty so that each may succeed.

   c. Each piece of apparatus should be:

      a. simple so that attention may be focused on significant observations
      b. so designed as to clearly show-perhaps to magnify-the quality being observed.
      c. safe to use
      d. easy to manipulate
      e. relatively durable
      f. relatively inexpensive
      g. easy to store

INTRODUCTION

The teaching procedures offered in this program are experimental. The teacher is offered the flexibility required to meet the needs of the different pupils while directing their learning activities in a meaningful, sequential manner. The major emphases are placed on concrete experiences and the quality of experiences rather than on the quantity of content.

The material is written with the assumption that the students have a limited reading ability and a poor command of the English language. The formal textbook has been eliminated placing the responsibility of instruction entirely in the hands of the teacher. He must direct the learning processes by means of student-teacher verbal interactions with emphasis being placed on oral discussions, reinforcements, and the development of a sound scientific approach. One of the basic problems--that of communication--can be greatly alleviated by initially utilizing the students' colloquialisms. Extensive use of audio-visual materials is necessary to provide meaningful concrete experiences.

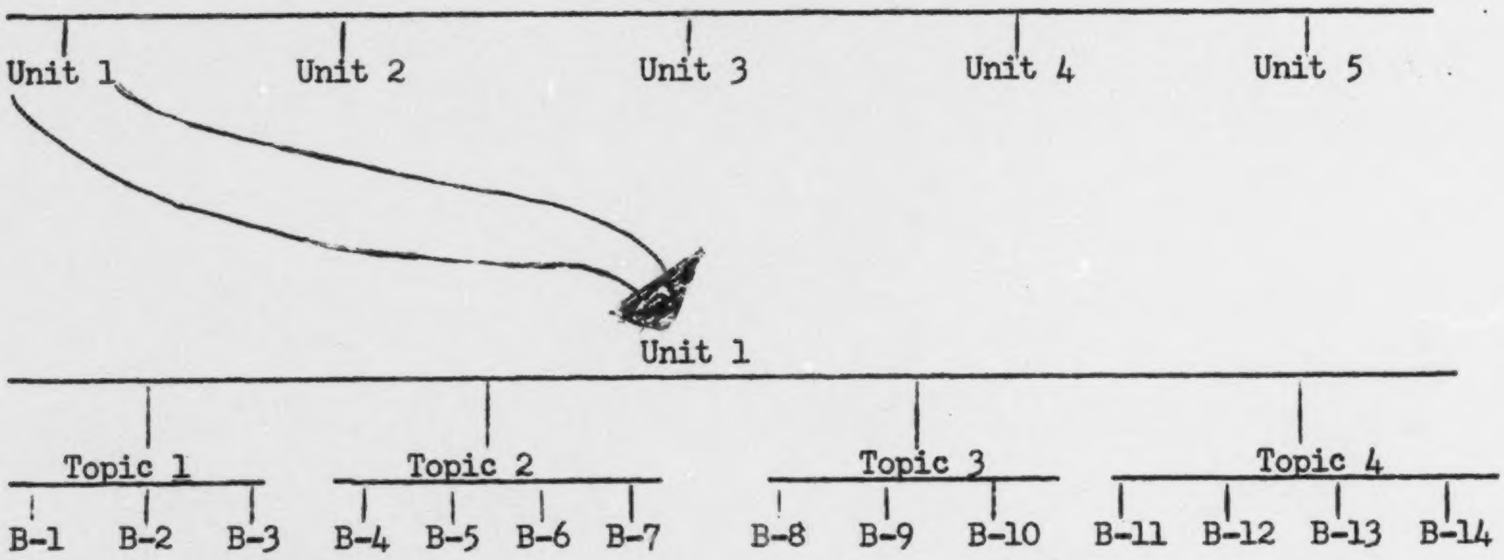
The teaching will normally progress through three phases:

1. Initial discussion supported by audio-visual materials to stimulate interest.
2. Small group laboratory activities supported by discussions of particular relevant information.
3. Final discussion to establish a conceptual framework and lead into the next topic.

A suggested format for the teacher to follow in directing the class is presented in detail. Suggested comments to be made by the teacher to the class are written in CAPITAL LETTERS; suggested procedures and anticipated responses are written in small type. Printed materials to be used by the students are designated by the letter "B" followed by a sequential number (B-2). These are to be issued to the students at the discretion of the teacher. This manual is only a guide for the teacher in preparing for class. It is not a student manual.

This manual is separated into units. Each unit contains several topics (statements of concept) which are demonstrated by several student activities. This may be graphically represented as:

Biological Science Manual



The TEACHER RESOURCE section is provided for the convenience of the teacher as a quick reference for related factual material. This is not necessarily the material to be presented to the class. The TEACHER DIRECTION section provides the materials and procedures to be used in the classroom.

At the beginning of each unit is a list of suggested films. These films are available from the County Film library 605 Ocean Street, 355-8871 Ext. 260. Choose one or two students to learn to operate the projector. When they are proficient make this their responsibility when films are shown.

The student written materials are being provided for the experimental classes. A copy of each activity has been inserted following the teacher directions in the teacher's manual. They are arranged in the order that they would normally be distributed by the teacher. Additional copies may be made by the various means of duplication.

Transparencies have been prepared for the experimental classes and are labeled the same as the activities they are to supplement. Printed copies of these transparencies may be produced by various thermo processes.

The program is being developed upon principles, procedures, and techniques found to be effective in working with all children. The guidelines and assumptions basic to DISCUS are also basic to sound teaching practices and classroom behaviors in any part of the country.

The DISCUS program is written specifically for a select group of students in Jacksonville, Florida and therefore reflects the immediate community, appropriate reading level and a projected comprehension rate. Modifications to the program in these areas should make the DISCUS program appropriate for any group of students in any part of the country.

Topic 1 - The initiation of the discussion pattern is to establish rapport between the teacher and students.

The purpose of the introductory discussion is twofold; to establish a discussion pattern that reflects critical thinking and questioning, and to establish an initial rapport between the teacher and the students in the classroom. The topic consists of twenty-three separate optical illusions on transparencies to be placed on the overhead projector.[1] The students are to be encouraged to discuss the illusions freely and informally. It can be assumed that the students will be reluctant to participate for many reasons, some of which may be: (1) due to past experiences with failure, (2) peer group influences, (3) fear of giving wrong answers resulting in ridicule, and (4) being conditioned not to participate. The teacher must establish an atmosphere conducive to free discussion and questioning. Each student reply should be accepted, modified as necessary, and reinforced as a contribution. By design, optical illusions will serve this purpose quite well for there is not one entirely correct answer that can be determined without intensive questioning. Use as many of the illusions as needed to establish the initial rapport.

The optical illusions should stimulate interest and improve communication in all three phases of teaching. This introductory activity is designed to "break the ice" and for orientation. The teacher should talk as little as possible but should not be reluctant to capitalize on points and suggestions that lead to the development of the pre-determined goals--that is to establish rapport and critical thinking.

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1. These may be purchased from the 3-M Company. Approximate cost is $35.00

Most of what the teacher says is said in question form rather than expository form. His responses to student statements are largely questions or suggestions. An example would be if a student questions whether or not a line is straight, suggest the use of a straight-edge to determine the answer. The results of the discussion should develop the idea that only through questions and investigations can answers and solutions be determined.

TEACHER DIRECTION

Place a transparency of an optical illusion on the overhead projector, WHAT DOES THAT THING LOOK LIKE? Encourage extensive discussion. Answer questions with question such as "What do you think it is?" or solicit voluntary answers from the class. Capitalize on and encourage students' suggestions for determining answers in a scientific manner such as observing, measuring, inferring, and experimenting.

Follow the same procedures for other transparencies.

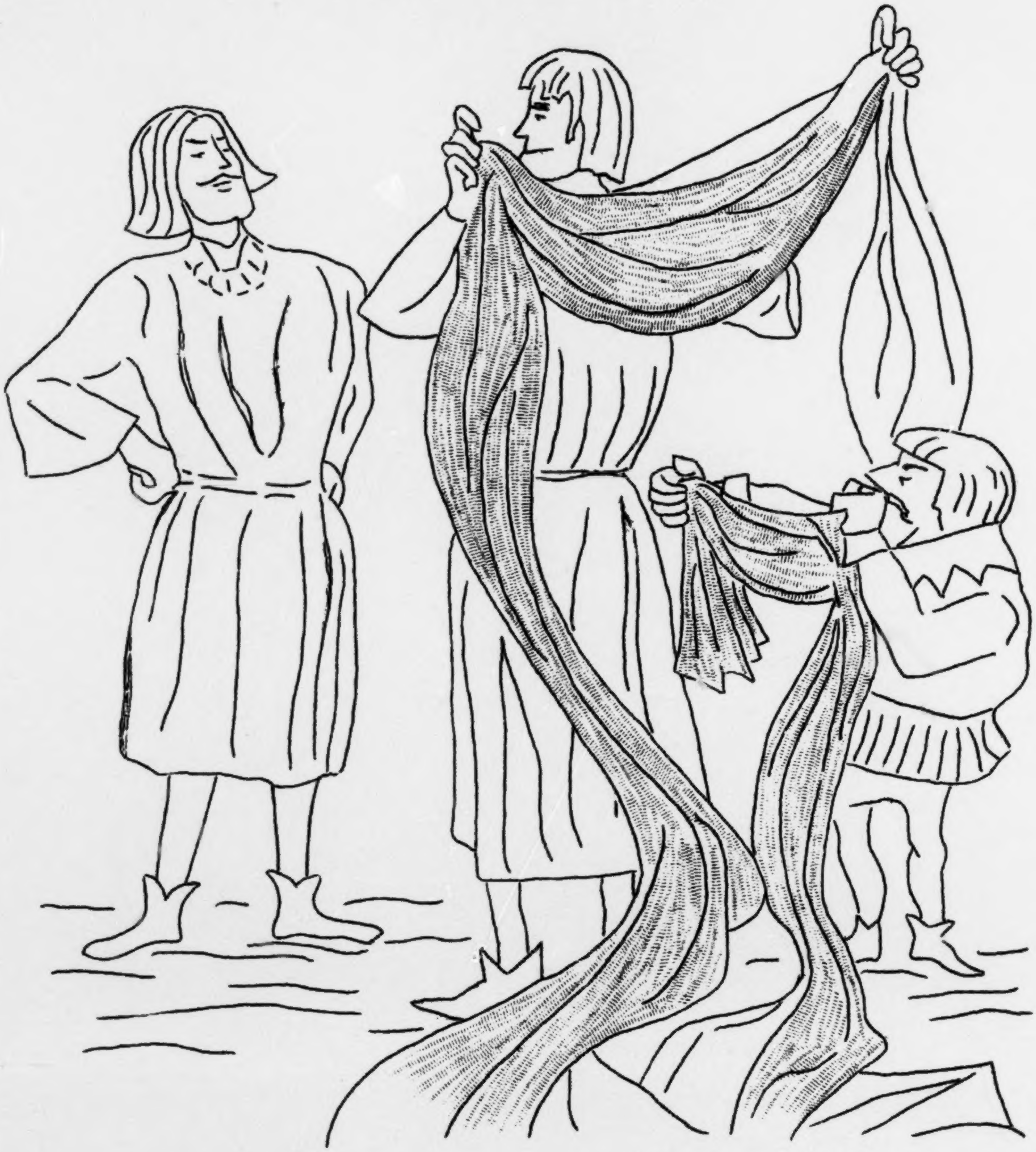
In conclusion, point out that the same object may appear different to different individuals. This is a problem of science. Interject the idea that individuals are different in thought as well as appearance. Examples are how fat is "fat", how tall is "tall", where is "there".

SUGGESTED FILMS

The following films have been previewed by the DISCUS staff. These films are suitable for DISCUS classes and are matched with the appropriate activity below. Films may be ordered through the County Film Library.

UNIT I	MEASUREMENT
B-1	WEIGHTS and MEASURES LET'S MEASURE INCHES, FEET and YARDS
B-2	
B-3	ALL ABOUT TIME (BELL TELEPHONE)
B-4	THE MYSTERY OF TIME HOW TO MEASURE TIME
B-5	
B-6	THERMOMETERS and HOW THEY WORK
B-7	SOLIDS, LIQUIDS and GASES
UNIT II	ECOLOGY
B-8	MARINE LIFE WHAT IS ECOLOGY THE COMMUNITY HOW NATURE PROTECTS ANIMALS
B-9	LIFE IN THE SEA THE SEA
B-10	FISH IN A CHANGING ENVIRONMENT
B-11	BLESSING FROM THE SEA
B-12	THE MARINE BIOLOGIST
B-13	LIFE IN THE OCEAN
B-14	
B-15	WHAT IS A FISH SEA ZOO UNDERSEA LIFE
B-16	
B-17	TREES AND HOW WE IDENTIFY THEM
B-18	INSECT MOUNTING and PRESERVING

MEASUREMENT



UNIT I MEASUREMENT

TEACHER RESOURCE

Teachers have reported that the students entering junior high school lack sufficient experiences and skills in measurement. DISCUS being a laboratory centered approach, involves the use of measurement and the tools of measurement. In this beginning unit an attempt is made to keep the activities very simple and yet with enough depth to relate to more involved principles. The student will be exposed to a few pieces of basic laboratory equipment that he will use throughout the year, and to the use of this equipment in making measurements.

The first activity is a reading activity. Students should be given time in class to read the material or the teacher may wish to read it to the class as they follow along. The reading should arouse some questions from the students, and sufficient time should be allowed for discussion of measurement before beginning the activities. A complete set of transparencies is provided for use with this reading activity. Additional copies of the wall chart on measurement are available from: Ford, Educational Affairs Department, The American Road, Dearborn, Michigan

The activities included in Unit I are:

*B-1	HOW IT STARTED - Introduction of Measurement Film: WEIGHTS and MEASURES LET'S MEASURE INCHES, FEET and YARDS
B-2	BUILDING A SIMPLE BALANCE
*B-3	WHAT TIME IS IT? Film: THE MYSTERY OF TIME - Film Library ALL ABOUT TIME - (Southern Bell Telephone
B-4	MEASUREMENT OF TIME
B-5	TOOLS OF MEASUREMENT
B-6	MEASUREMENT OF TEMPERATURE Film: THERMOMETERS and HOW THEY WORK SOLIDS, LIQUIDS and GASES
B-7	MEASUREMENT OF MELTING POINT

* Reading Activities

STUDENT B - 1

HOW IT STARTED

How old are you?

How much do you weigh?

What size shoe do you wear?

What time is it?

How fast are we going?

You have probably heard one or more of these questions many times. All of these questions have something in common they all relate to measurement of one type or another. Each of us use measurements everyday of our lives. Early man was not too concerned with measurement and if measurements were needed he probably used the most convenient object available to measure with; perhaps a foot or a hand. Many of these measurements remain with us today, for example, we still talk of horses being so many hands tall. Another unit we hear of today is the acre. This unit originally was the amount of land a yoke of oxen could plow in one day. One of the earliest units invented was the cubit. Originally this was the distance from a man's elbow to the tip of his middle finger. The Bible speaks of Noah's ark being 300 cubits long, 50 cubits wide and 30 cubits high. Can you find it's dimension in inches and feet? The inch probably originated as the width of the thumb. As we think about these crude measurements we can see something common to all, they were subject to great variation. Their values depended mainly on the size of the person doing the measuring. This fact caused a great deal of confusion and led eventually to the establishment of legal standards. At first the legal standards would vary from place to place, for example, in one tribe the standard might be the length of the chief's foot. This length was then measured off on sticks and all members of the tribe would accept this as a legal foot. Of course this was not as convenient as using one's own foot but it did prevent a lot of confusion.

Student

What do you suppose would happen when people began to travel from one village to another?

This brings us to some of the problems of measurement we still face today. Some countries use a system of measurement called the Metric System and some use the English System. This again leads to confusion among countries. Many countries today have switched to the Metric System. Our own country has not done this yet. Can you think of any **reasons why**? Even though the United States does not use the Metric System completely, most American scientists use this system in their work.

Streets are measured in blocks, the school day is measured in periods, your age in years and on and on the units of measurement go. Regardless of the area in which you live or eventually will work measurement will play an important part in your life.

TEACHER RESOURCE

TO BE USED WITH TRANSPARENCIES ON MEASUREMENT

THE BEGINNING

FROM EARLIEST TIMES, MAN HAS WORKED AT DEVISING STANDARDS OF MEASUREMENT. PRIMITIVE MAN PROBABLY USED PARTS AND MOVEMENTS OF HIS BODY-HIS FINGERS, HANDS, PACE-TO DESCRIBE LENGTHS AND QUANTITIES. AND, WHEN THE FIRST "FISH STORY" WAS TOLD, A CAVEMAN PROBABLY SCRATCHED THE MEASUREMENT OF HIS CATCH ON A CAVE WALL TO PROVE ITS SIZE.

THE CUBIT

AS CIVILIZATION DEVELOPED, DEFINITE STANDARDS OF MEASUREMENT BECAME NECESSARY. FOR TRADING, BUILDING, AND SCIENCE. THE CUBIT, USED BY THE BABYLONIANS AND EGYPTIANS, WAS THE FIRST UNIT OF MEASUREMENT RECORDED BY HISTORY. THE MEASUREMENT OF THE CUBIT WAS THE LENGTH OF A FOREARM FROM ELBOW TO MIDDLE FINGER-TIP, AND ITS SYMBOL WAS THE FIGURE OF A FOREARM.

THE FOOT

A MODIFIED EGYPTIAN CUBIT -- THE OLYMPIC CUBIT-WAS USED BY THE GREEKS AND ROMANS. IT WAS EQUAL TO OUR 18.24 INCHES. TWO-THIRDS OF THIS OLYMPIC CUBIT BECAME THE FIRST UNIT TO BE CALLED A FOOT. AND, AS THE ROMAN LEGIONS MARCHED ACROSS THE WORLD, THEY BROUGHT THE FOOT MEASUREMENT TO THE NATIONS THEY CONQUERED, INCLUDING GREAT BRITAIN.

THE INCH

THE GREEKS SUBDIVIDED THE FOOT INTO TWELVE THUMBNAIL BREADTHS, WHICH THE ROMANS CALLED "UNICAE" TO "INCH", AND, IN THE 14TH CENTURY, KING EDWARD II DECREED THAT THE INCH WAS THE LENGTH OF THREE BARLEY CORNS, ROUND AND DRY, TAKEN FROM THE CENTER OF THE EAR AND LAID END TO END.

THE FATHOM

THE MAJOR OCCUPATIONS OF A PEOPLE DETERMINED, TO A GREAT EXTENT, THE MEASUREMENTS THEY DEVELOPED. THE ENGLISH WERE SAILORS, SO ONE OF THEIR IMPORTANT MEASUREMENTS WAS THE FATHOM, A UNIT USED TO MEASURE THE DEPTH OF WATER. THE WORD "FATHOM" MEANT OUTSTRETCHED ARMS, AND ONE FATHOM EQUALLED THE LENGTH ACROSS A MAN'S TWO ARMS OUTSTRETCHED. TODAY ONE FATHOM IS EQUAL TO SIX FEET.

THE YARD

THE ENGLISH ALSO WERE MERCHANTS OF CLOTH. THEY DEVISED THE YARD TO MEASURE THIS VITAL TRADE PRODUCT--A MEASUREMENT EQUAL TO HALF-A-FATHOM OR THE DISTANCE FROM THE MIDDLE OF THE CHEST TO THE FINGER-TIP OF AN OUTSTANDING ARM. UNFORTUNATELY, THE MERCHANT WITH A SHORT ARM WOULD SELL A SHORTER YARD OF MATERIAL THAN A MERCHANT WITH A LONG ARM.

THE STANDARD YARD

UNIFORMITY IN MEASURES OBVIOUSLY WAS NEEDED TO REGULATE TRADE, SO ENGLISH KINGS ESTABLISHED STANDARDS BY ENACTING LAWS. KING HENRY I DECREED THAT THE LAWFUL YARD WAS THE DISTANCE FROM THE POINT OF HIS NOSE TO THE END OF HIS THUMB, BUT KING HENRY VII RULED THAT THE STANDARD YARD MEASURED THREE FEET, AND HAD THIS MEASURE MARKED ON A BRONZE YARD BAR.

THE ROD

THE ROD AND THE FURLONG WERE OTHER ANGLO-SAXON UNITS OF MEASUREMENT LONGER IN LENGTH THAN THE YARD OR THE FATHOM. TODAY, WE SAY THAT THE ROD IS 5½ YARDS LONG, OR 16½ FEET. BUT, IN THE SIXTEENTH CENTURY THE LENGTH OF THE ROD WAS DETERMINED BY LINING UP SIXTEEN MEN, LEFT FOOT-TO-LEFT-FOOT, AS THEY LEFT CHURCH ON SUNDAY MORNING!

TEACHER DIRECTION B - 2

BUILDING A SIMPLE BALANCE

Materials for groups of three:

1. 12 inch ruler
2. 2 large paper clips
3. Cardboard
4. Two 10 inch pieces of wire
5. Paper clips

In this activity we will introduce the student to the idea of a standard in connection with weighing. A standard may be any object agreed on, in this activity paper clips will serve as our standard. If you have a double pan balance bring it into class for students to look at, use and compare to their own balance. If you have any standard weights these may be measured in clips.

WHAT WOULD HAPPEN IF WE PUT TWO PEOPLE ON A SEE-SAW, ONE AT EACH END, IF THEY WERE EQUAL IN WEIGHT? IF ONE WEIGHED TWICE AS MUCH AS THE OTHER HOW COULD WE MAKE THE BOARD "BALANCE". (put another person on of the same weight) Try to keep away from the idea of the heavier boy moving nearer the center of the board, since levers and moments will be discussed later. Emphasize with the students that in all measurment we are comparing an unknown quantity such as: weight, time, volume, et al, to a known quantity.

STUDENT B - 2

BUILDING A SIMPLE BALANCE

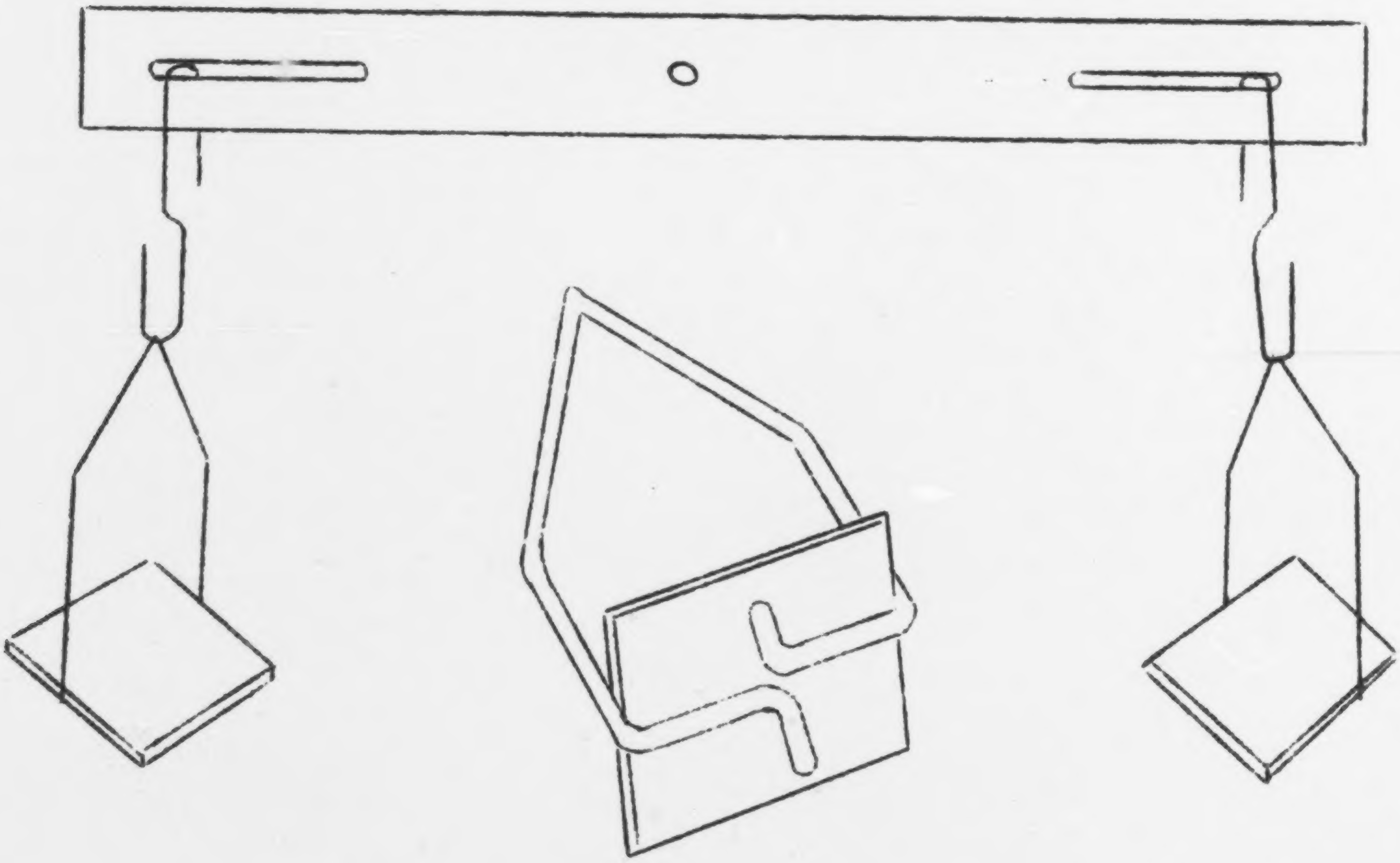
Materials for groups of three:

1. 12 inch ruler
2. 2 large paper clips
3. Cardboard
4. Two lengths of wire
5. Paper clips

The balance is probably one of the oldest pieces of equipment used for measurement. It was first used thousands of years ago to weigh gold dust. To use the **balance**, a pan is hung on each end of a beam at an equal distance from the center of the beam which is supported in the middle.

The object to be weighed is placed in one pan, then objects of known weight (standards) are placed in the opposite pan until both pans are balanced. Today you will build a simple balance and then weigh several objects.

WHAT YOUR BALANCE SHOULD LOOK LIKE



bottom view

Student
Page 2

After you have built the balance you are now ready to weigh some small objects. For standards we will use paper clips. For example how many paper clips does a pencil weigh? Weigh and record the weight (in paper clips) of the following.

1. Pencil ________________________ clips
2. Piece of notebook paper ________________________ clips
3. Penny ________________________ clips
4. Paper clip ________________________ clips
5. Other small objects:
    (a) ________________ ________________________ clips
    (b) ________________ ________________________ clips
    (c) ________________ ________________________ clips

Now weigh the same object using your partner's balance to see if the objects weigh the same.

1. What was the standard in this activity?
2. Do all paper clips weigh the same?

    Prove your answer
3. How could you explain the difference between your balance and your partners?

B - 3

WHAT TIME IS IT?

It is very important to most of us to know what time it is. School bells ring at the same time each school day. People get up, go to work, eat lunch and stop work according to clock time. Radio and T.V. programs are broadcast at definite times. Trains, buses, steamships and airplanes run on time schedules. There are few good excuses for being late for anything in today's world.

Important as time is for us today, man has not always known how to measure it. For early man, the measuring of time was a very difficult problem. Much thought was required before man learned to solve this problem.

Shadows were probably the first timekeepers. By watching the length and position of shadows, early man was able to gain some idea of the time of day. Later, special shadow sticks were used. After many centuries, sundials were invented. The marks on a sundial represented the hours. The shadow of a slanting stick traveled over these marks. It was then possible to tell the time of day by looking at the face of the sundial.

Since sundials were of no use at night or on cloudy days, men began to think of other ways of measuring time. Different kinds of water clocks were invented. Some of these used a jar with a tiny hole in the bottom. This jar floated in a larger jar of water. As water entered through the tiny hole, the smaller jar filled slowly with water. It was possible to tell the time of day by noticing the height of the water in this jar.

In other kinds of water clocks, water was allowed to fall, drop by drop, into a tall jar. The hours were marked on the side of the jar. Sometimes a floating object with a stick fastened to it was placed in the jar. As the jar filled with water, the floating object was pushed upward.

The first watches were made about six hundred years ago. They were egg-shaped, but were much larger and heavier than eggs. They were called watches because they were carried by night watchmen, who called off the hours during the night.

Early watches and clocks did not keep time very well. They were often more than an hour too fast or too slow. The first really satisfactory clock was made only a little over three hundred years ago. It has a pendulum that swung back and forth, just as pendulums in clocks do today. Each swing of the pendulum required the same amount of time. At the end of each swing, the pendulum was given a little push to keep it swinging. A heavy weight attached to a chain inside the clock furnished the power to do this.

All the clocks and watches in the world are made to keep time with the turning of the earth. We call the time required for each rotation of the earth a day. Each day is divided into twenty-four hours. Each hour is divided into sixty minutes.

Although we divide each day into twenty-four hours, our watches and clocks show only twelve hours. The hour hand of a clock makes two "round trips" each day. From midnight until noon we say the time is a certain hour A.M. Without this system, we should have to have clocks with twenty-four hours shown on their faces. Such clocks are used in some countries. Instead of saying A.M. and P.M., the people in these countries give the hour of the day from one to twenty-four. One hour past noon is 13 o'clock. One hour before midnight is 23 o'clock. Military time is kept in a similar manner, one hour past noon being 1300 hours.

Correct time is now obtained from the stars. Through a telescope the stars are seen to move from east to west, as the earth turns. Astronomers know what time each star will be in a certain place in the sky. For this reason, it is possible to find the correct time by watching stars through telescopes.

In the United States, the United States Naval Observatory at Arlington, Virginia keeps track of the motions of the earth and stars, and from them gives us the correct time. Several master clocks are kept running in this observatory. Their time is kept correct by observations of the stars made through telescopes. Clocks in Western Union telegraph offices throughout the country are connected with these master clocks by electric wires. Thus, all Western Union clocks in the same time zone show exactly the same time. Many broad-casting stations also give the correct time several times a day. The Arlington time signals sent out by broad-casting stations are correct to within 1-100 of a second.

TEACHER DIRECTION

B - 4

MEASUREMENT OF TIME

Film: HOW TO MEASURE TIME
THE MYSTERY OF TIME

Materials for groups of three:

1. String
2. Weight
3. Beaker
4. Funnel
5. Sand

An excellent film "ALL ABOUT TIME" produced by the Bell Telephone System should be used to introduce this activity on the measurement of time. The film may be obtained at no cost from the Downtown Public Library.

In a pendulum there is a relationship between the length of and the interval between swings. The longer the string the longer the interval. By varying the length of the string the students should be able to arrive at approximately 60 swings per minute or 10 swings per second.

This is the method behind the pendulum clock in use around the end of the 17th Century. You may want to bring in an old clock for students to open and examine the pendulum or the parts that replaced it.

A simple hour glass: By varying the amount of sand through the funnel students again should be able to approach a one minute interval.

Answers to activity questions:

(1) As the string length is varied the number of swings also varies.

(1) The long string produces a longer interval.

(3) The short string produces a shorter interval.

(4) Time could be measured using dripping water, sundial, et al.

STUDENT

B - 4

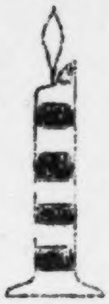
MEASUREMENT OF TIME

Materials for groups of three:

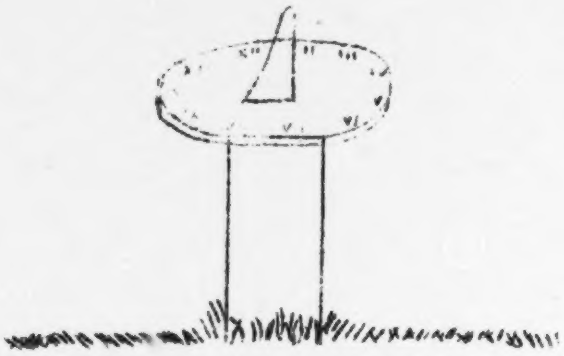
1. String
2. Weight
3. Funnel
4. Beaker
5. Sand

One of the oldest measurements man has been interested in is time. At first the measurement was the rising and setting sun. Later this was improved by the use of the sundial and other such devices. Many simple devices have been used to measure time such as:

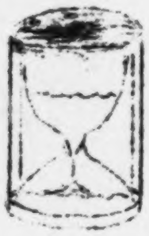
A. Burning candle



C. The Sundial



B. The hour glass which uses sand



A great advancement in the measurement of time came with discovery of the swinging pendulum by a young man named Galileo. Galileo noticed a swinging lamp on a long chain and found that by comparing his pulse rate to the swinging lamp he could predict the interval between the swings.

Part A Let's make a pendulum. Take a piece of string and attach a weight to the end. Now have one member of the group watch the second hand on the clock. See how long it takes to swing ten times. (2) Change the weight and try it again. (3) Vary the length of the string and again record the number of swings for one minute. (4) Change from a wide swing to a narrow swing. (1) Is the number of swings the same?

Student
Page 2

(2) What effect does a long string have on the number of swings? (3) What effect does a short string have? Now using your pendulum try to tell when one minute is gone without looking at the clock.

Part B Now fill a funnel with sand and determine how many seconds are needed for the sand to flow out into the beaker. Regulate the amount of sand until you have enough for ½ minute. (4) Can you think of any other ways of measuring time?

State the following times using military time:

(a) 12:00 (noon)

(b) 1:30 p.m.

(c) 1:30 a.m.

(d) 3:00 p.m.

(e) 3:00 a.m.

(f) 12:00 (mid-night)

TEACHER DIRECTION B - 5

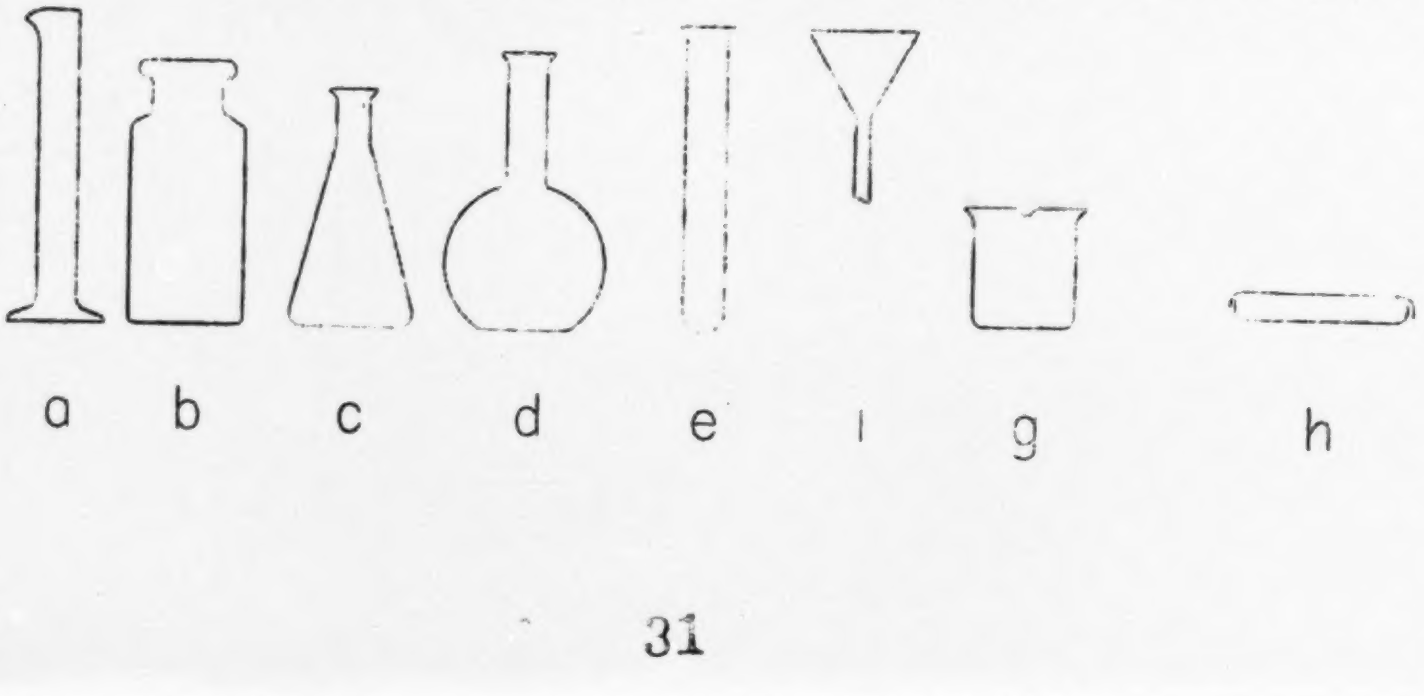
THE TOOLS OF MEASUREMENT

Materials for groups of three:

1. Graduated cylinder
2. Two different size beakers
3. Test tubes
4. Various pieces of equipment & glassware

In this unit we will not get into a detailed study of the Metric System. However, students should know the milliliter unit and its abbreviation (ml) since most of the glassware they will be using is graduated in this unit. You may wish to tell them that the prefix milli equals one thousand and that a liter is approximately one quart. One liter then is equal to one thousand milliliters. You should also discuss the millimeter abbreviated (mm) most have probably heard "the silly millimeter longer" jingle. The milli prefix equals a thousand and the meter is a little longer than the yard thus, one thousand millimeters equals one meter. The students maybe familiar with some objects measured in Metric System units for example movie film 16 millimeter, 8 millimeter.

You should have the pieces of glassware pictured in this activity out on the front desk and also use the transparency (B-5) showing this equipment. Students should become familiar with the name of each. A quiz either oral or written should be given at the end of the activity to make sure students are able to identify the equipment used. A transparency B-5 has been prepared for this purpose.



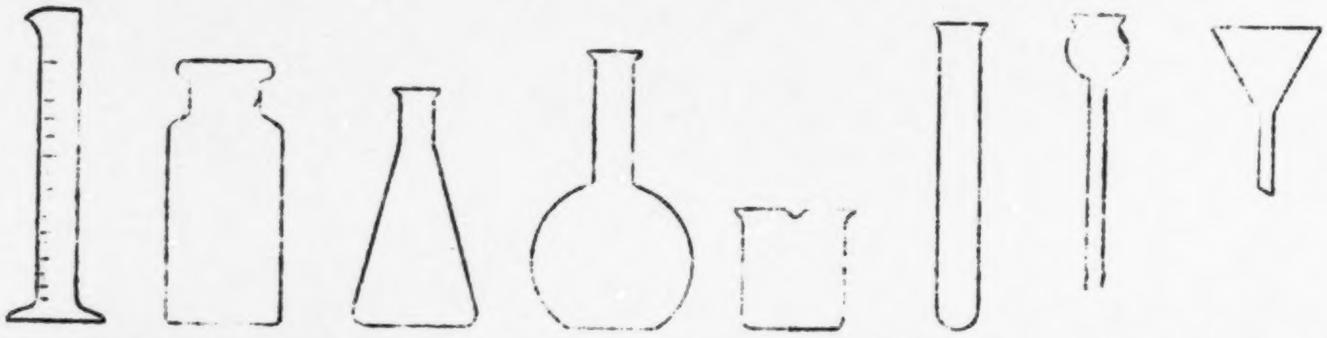
B - 5

THE TOOLS OF MEASUREMENT

Materials for groups of three:

1. Graduated cylinder
2. Two different size beakers
3. Test tubes
4. Various pieces of glassware and equipment

Scientist use many different kinds of equipment in the laboratory. Much of this equipment is made of glass. You will need to know the names of these pieces of equipment since you will be using all of them. Throughout the year you will be using measurement in your laboratory activities. One measurement you will use quite often is volume. Volume is simply the amount of space something fills. You probably use such measurements everyday: pint, quart, gallon. Most of the glassware you use will be marked in units of the Metric System called milliliters.



Some pieces of equipment are referred to as being "graduated" for example, graduated cylinders, graduated beakers. This simply means that equipment is marked in units for easy measurement.

Now examine your graduated cylinder:

What is its volume in milliliters? (ml) ______________________

What does each small mark represent? ______________________

What does each large mark represent? ______________________

Measure out 10 ml. of water in the graduated cylinder and compare yours with another group.

Student
Page 2

Now find out how much water is required to fill:

Test tube ______________________________ ml

Beaker _________________________________ ml

Flask __________________________________ ml

Other measurement activities:

Figure:

(1) Average foot size for boys; for girls in your class.

(2) Average heighth for boys; for girls in your class.

(3) Average weight for your class.

TEACHER DIRECTION B - 6

MEASUREMENT OF TEMPERATURE

Film: THERMOMETERS and HOW THEY WORK

Materials for groups of three:

1. Centigrade thermometer
2. Fahrenheit thermometer
3. 250 ml beaker
4. Burner

If dual thermometers are available for this activity, this would prevent the necessity of students working with two different thermometers. Caution them to be sure as to the scale they are reading. The tip of the thermometer should not be used as a stirring rod. The tip should also be kept away from the glass sides of the beaker since this will affect the reading.

Due to the impurity of the water most of the students will get boiling points other than the standard 100 degrees Centigrade or 212 degrees Fahrenheit. These standards are based on pure water. Boiling point is also effected by changes in barometric pressure, for example, water on a very high mountain would boil at a much lower temperature than water at sea level. Cars traveling up Pikes Peak often experience difficulty with the radiator water boiling over due to its low boiling point at this altitude. People at such high altitudes must use pressure cookers for all cooking that involves boiling since at these high altitudes the water boils at such a low temperature the water will not get hot enough to cook food. Students should be reminded that it is the temperature that cooks in the boiling process -- rather than the boiling itself. It is not necessary for our purposes that students be able to convert from Centigrade to Fahrenheit, however, by using the acetate (B-6) they should see that one degree Centigrade is larger than one degree Fahrenheit.

Answer to questions in student activity:

1. Due to the impurity factor, probably the water die not boil at 100°C and 212°F.
2. Impure water, error in thermometer, error by student reading the thermometer.
3. The heat of the glass will give higher reading than the water.

4. All liquids do not boil at the same temperature as water, for example: alcohol, ether, gasoline, etc.
5. Boiling is the temperature at which liquids turn to vapor which may be seen as bubbles of vapor.

If students seem interested in the topic of temperature you may mention the relationship of solids, liquids, and gases using water H_2O as an example.

Why is oxygen a gas? Because it has such a low boiling point.

Why is iron a solid. Because it has such a high boiling point.

Other interesting questions for class discussion or research:

(a) How high can the human body temperature go during fever before death or cell damage occur?

(b) How low can body temperature go without causing death?

(c) What is the lowest temperature possible?

(d) Research the preservation of life by Cryogenics.

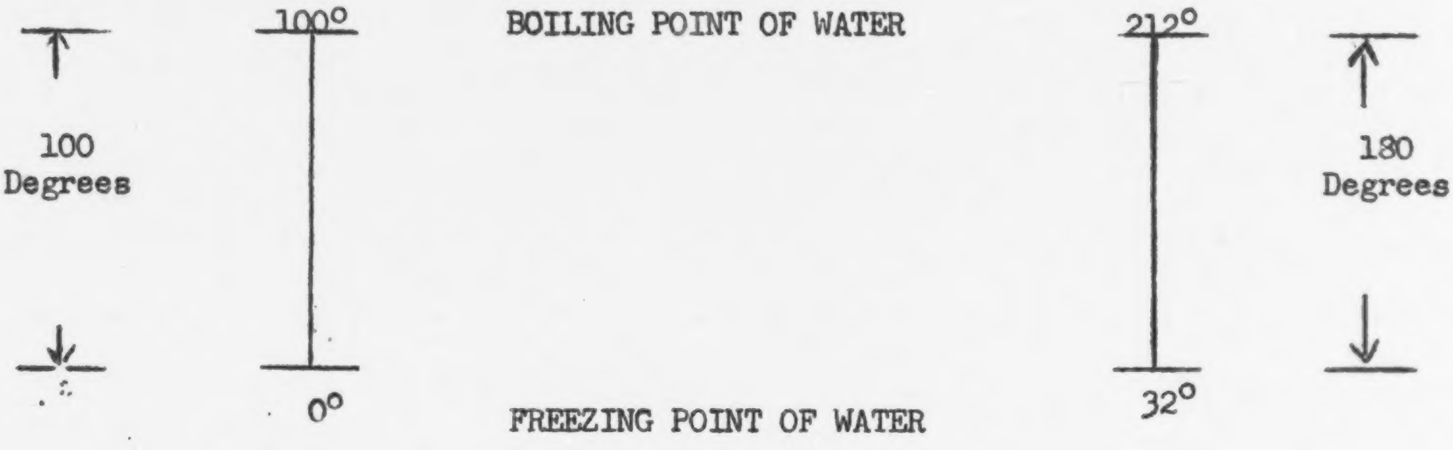
STUDENT B - 6

MEASUREMENT OF TEMPERATURE

Materials for groups of three:

1. Centigrade thermometer
2. Fahrenheit thermometer
3. 250 ml Beaker
4. Burner

The two most commonly used temperature scales are the Centigrade and the Fahrenheit scales. Some thermometers you use may have both of these scales on the same thermometer. If you were to place one of these dual thermometers in a beaker of water and heat the water to boiling and then note the temperature, you would find water boiling at approximately 100 degrees on the centigrade scale and 212 degrees on the Fahrenheit scale. This does not mean that water boils at the two different temperatures but rather that the same distance is divided into smaller units on the Fahrenheit scale.



Most of the temperatures we are familiar with are Fahrenheit temperatures such as human body temperature 98.6°F. and weather report temperatures.

Place a beaker half-filled with water over the burner and heat the water to boiling. As you begin the heating, place the thermometer into the water and read the temperature every two minutes. This reading should be recorded on the chart. As you check the temperature be very careful around the flame. Make sure the tip of the thermometer does not touch the bottom of the beaker. After you have completed your readings, find someone that is using another scale and exchange readings so that you may complete the chart for both the Fahrenheit and Centigrade scale.

TEMPERATUR OF WATER:	CENTIGRADE	FAHRENHEIT
AT START OF ACTIVITY		
AFTER: 2 minutes	________	________
4 minutes	________	________
8 minutes	________	________
10 minutes	________	________
12 minutes	________	________

After you have completed the chart hold the tip of the thermometer just above the surface of the water and take a reading. Is this temperature above or below the boiling point temperature? Why or Why not?

1. Did the water boil at 100°Centigrade or 212° Fahrenheit?
2. If not, what reasons can you give?
3. Why is it important that the tip of the thermometer not touch the bottom or side of the beaker?
4. Do you think all liquids would boil at this same temperature?
5. How can you tell when you had reached the boiling point of water?
6. In an open beaker can you raise the temperature of the water higher than this temperature?
7. What was the temperature just above the water? ________________

TEACHER DIRECTION B - 7

MEASUREMENT OF MELTING POINT

Film: SOLIDS, LIQUIDS and GASES

Materials for groups of three:

1. Thermometer
2. 250 ml beaker
3. Ice
4. Soda Straw

Students after completing this activity should be aware that melting point and freezing point are the same. The use of these terms depends on the direction in which the temperature is going, whether it is going up or down.

In this activity the temperature [illegible] the ice is much lower than the temperature of the water. In order to test this, students would have to drill a hole the size of the thermometer in the ice so the tip of the thermometer would be surrounded by the ice. Again temperature readings will vary. Students may attempt to get the temperature below 0°C or 32°F.

Answers to questions in the student activity:

1. No impurities in the water
2. Students were measuring the temperature of the water. The thermometer would need to be surrounded by ICE to measure the temperature of the ice.
3. 32°F and 0°C
4. 32°F and 0°C
5. No, it becomes a solid, Ice.

STUDENT

B - 7

MEASUREMENT OF MELTING POINT

Materials for groups of three:

1. Thermometer
2. 250 ml Beaker
3. Ice
4. Soda Straws

Half fill a beaker with ice and then add enough water to cover the ice. Stir the ice with a soda straw. Then place the thermometer in the center of the mixture. Do not stir with the thermometer. This may cause it to break. Stir with the straw while reading the temperature. Repeat this process until you get the temperature of the water as low as possible.

1. Did the temperature reach the freezing point of water?
2. Were you measuring the temperature of the ice or of the water?
3. At what temperature does water freeze?
4. At what temperature does ice melt?
5. Can you get the temperature of water, the liquid, below its freezing point?

UNIT 2

ECOLOGY

UNIT II

ECOLOGY

Ecology deals with an organism and its relationship to its environment. In this series of activities students are exposed to the "Balance of Nature" the effect of pollution and predators on this delicate balance and the great variations within a small segment of life. Also how one would go about determining the approximate number of a particular organism in a particular area. Those activities included are:

*B-8	WHERE HAVE ALL THE TURTLES GONE: Film: MARINE LIFE WHAT IS ECOLOGY THE COMMUNITY HOW NATURE PROTECTS ANIMALS
*B-9	LIFE IN THE SEA Film: LIFE IN THE SEA
B-10	CYCLE OF LIFE
*B-11	WATER POLLUTION
B-12	WATER POLLUTION AND LIFE Film: THE MARINE BIOLOGIST
B-13	TYPES OF AQUATIC LIFE Film: LIFE IN THE OCEAN
B-14	GROUPING (Classification)
B-15	GROUPING FISHES Film: WHAT IS A FISH
B-16	GREEN GREEN
B-17	GROUPING LEAVES Film: TREES AND HOW WE IDENTIFY THEM
B-18	GROUPING INSECTS Film: INSECT MOUNTING AND PRESERVING
B-19	RANDOM SAMPLING

* Reading Activity

WHERE HAVE ALL THE TURTLES GONE?

Each year in late spring a very unusual event occurs. Hundreds of giant green sea turtles crawl ashore to lay their eggs. On moonlight nights the females crawl just beyond the high tide line on the beach and dig deep holes in the sand. Each female will lay about 150 eggs in these holes, and the eggs will then be carefully covered up. Afterwards the female crawls back to the ocean and remains there until the next egg-laying season.

In a short time the eggs will hatch. It is here that another unusual event occurs for all of the eggs hatched at the same time. The newly hatched turtles make their way to the water where they begin to feed. It will require about seven years for the females to become mature enough to produce eggs. A sad part of this story is that not all of the newly hatched turtles will make it to the water.

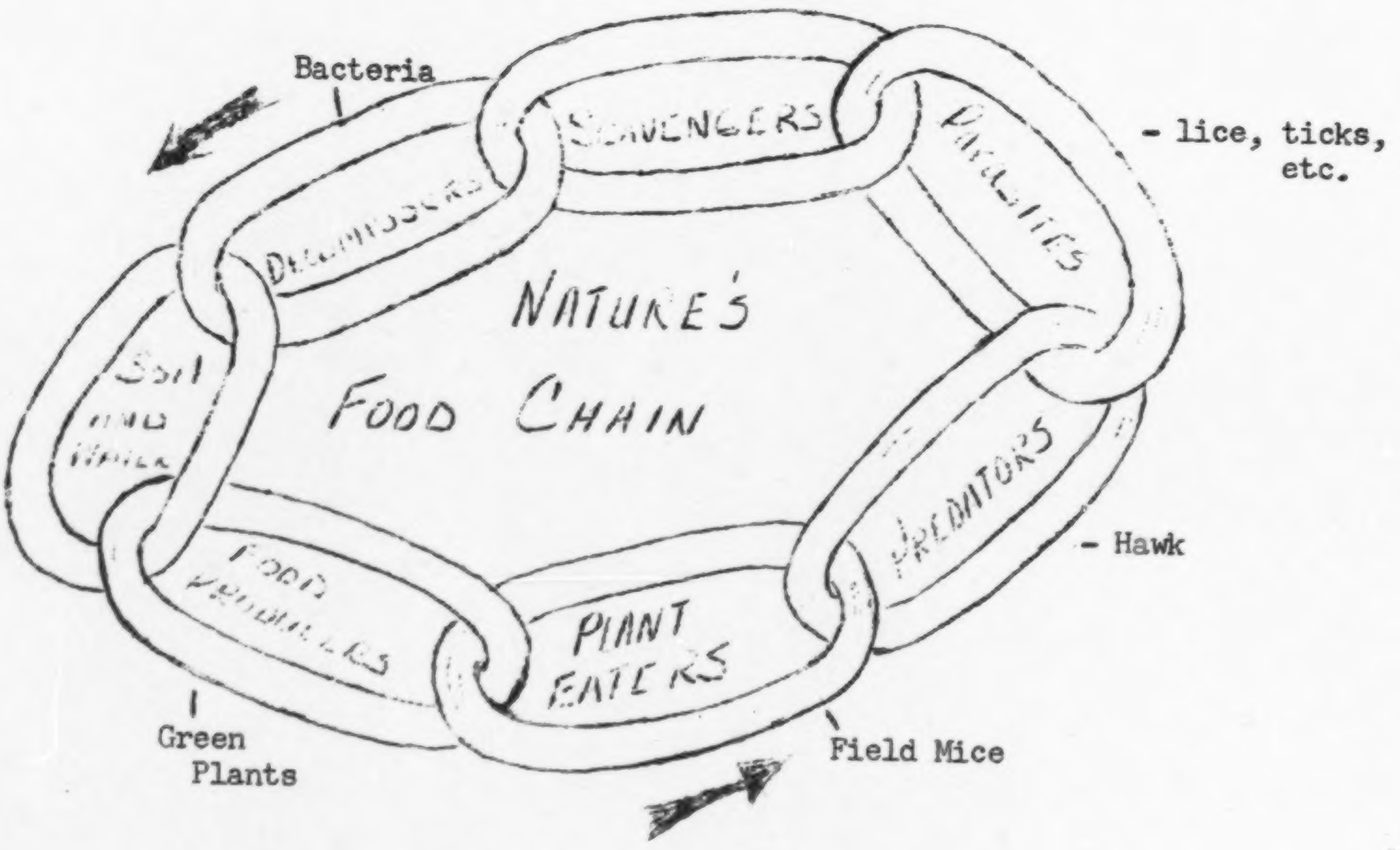
Let's suppose for a minute that all of these turtles did survive. Of the 150, probably 75 will be females capable of producing more eggs in approximately ten years. During this time the original females will have produced about 1500 eggs each. If this rate continued for many years, the oceans of the world would not be able to contain all of the turtles. In fact, the ocean would be solid turtles. We all know this does not happen. Many of the eggs never hatch. They are destroyed by man who digs up the eggs and uses them for food since they look and taste much like a hen's egg. The raccoon and other small animals find many of the nests and destroy them.

Even though many of the eggs do hatch, they never make it back to the water. As the small turtles begin the journey from the nest to the sea, other dangers are waiting. Skunks, snakes, raccoons, and other animals feed on the small turtles. Even those that survive these dangers must still get past the gulls and other birds along the shore that feed on them. Once they reach the water, large fish and sharks destroy many of them before they become adults.

Student
Page 2

So you see, out of our original 150 eggs only a few, approximately three, will ever reach adulthood. As tragic as it may seem, this is nature's way of balancing the turtle population. This is also true of almost any animal you may think of, for all must constantly wage a battle of survival. Almost any animal may go out looking for dinner and end up being the dinner of some other animal.

In nature there are food producers, plant eaters, predators, parasites, scavengers, and decomposers. Each plays a very important role in what we call a food chain.


Bacteria
SCAVENGERS
PARASITES
- lice, ticks, etc.
DECOMPOSERS
NATURE'S FOOD CHAIN
SOIL AND WATER
PREDATORS
- Hawk
FOOD PRODUCERS
PLANT EATERS
Green Plants
Field Mice

STUDENT

B - 9

LIFE IN THE SEA

The underwater world is 3 times as large as the surface world above the water. In our world above water, animals, including man, have advanced to the point that they may not have to eat each other. In the underwater world of our ponds, lakes, streams and the sea, life is much more uncertain and dangerous. The big eat the little in order to survive. From the 1,000 pound shark eating a hundred pound tuna down to the one ounce minnow chewing up a tiny fish egg, this vicious cycle goes on each day. Only the strong, the quick, and the alert survive. This life is termed the Vicious Aquatic Cycle of Life.

All life in the sea begins with fertilizer. This fertilizer comes from dissolved minerals washed from the land into the water and from the millions of tiny water plants and animals that die and decompose in the ocean each day. Even the whale that may weigh tons has to die sometime, thus adding his terrific bulk to the aquatic fertility. As this fertilizer is added to the water tiny plants and animals (plankton and algae), that you and I cannot see, even with our magnifiers, are constantly feeding and growing on these particles of fertilizer. At the same time the Crustaceans (insects of the sea) and newly hatched fish are eating these microscopic plants and animals. In turn, waiting behind each rock or plant are larger fish such as mullet, catfish and bream, called (Forage fish), since they do not feed on other living fish. These fish feed on the Crustacean and plant life in the sea. Even though such fish are large in comparison to the food they eat, they are far from safe. The larger fish that feed on living fish are always hiding and waiting to catch a mullet or bream off guard. These larger fish are termed Carnivorous because they feed on other living fish. These carnivorous fish fight among themselves and when one is injured the others turn and devour their own kind. As these large fish grow old they too die and return to fertilizer, thus completing the cycle.

This life cycle has no time-outs, no half time, no quarters. The animal that is careless or weak cannot live.

TEACHER DIRECTION

B - 10

CYCLE OF LIFE

Film: FISH IN A CHANGING ENVIRONMENT

Materials for groups of three:

1. Four -- one gallon jars or small aquria
2. Two -- Babyfood jars.
3. Approx. 20 small minnows secured from ditch or pond. (Goldfish do not work well).
4. A quantity of ditch or pond water to fill the gallon jars approx. 3/4 full.
5. Several rooted aquantic plants with enough soil remaining on roots to fill 2 babyfood jars.
6. 4 pieces of masking tape numbered 1 - 2 - 3 - and 4.
7. One Fahrenheit thermometer
8. 10 strips of litmus paper.

Bury the roots of several plants in each babyfood jar, and place on the bottom of two of the gallon jars. Fill 3/4 full of water (natural pond water if possible). Add from 5 to 10 small minnows. It is best to over stock each jar for quick results to the activity. These jars should be numbered one and three.

Fill two jars 3/4 full of water and add the same number of minnows as before but omit the plant life. Number these jars two and four.

Place jar number one containing fish and plant life and jar number two containing fish with no plant life in the darkest area of the room (Shade to semi darkness if necessary).

Then place the two remaining jars number three and four containing the exact material as above in the window where direct sunlight is abundant. (Artificial light will not work as well).

Let both units remain in the above position without food for 5 to 7 days. Have students record observations daily beginning with the second day.

The purpose of this activity is to show that without sunlight, the entire aquatic cycle will break down due to very slow growth of the algae. There will be marked activity of the minnows in both jars exposed to the sunlight. The rooted plants make little difference in these two jars due to the abundant supply of algae in the lighted area. A green deposit will form rapidly in both jars. The rooted plant will grow and remain healthy. In the dark area you will note unhealthy rooted plants and a marked reduction in the amount of algae growing in either jar. Fish mortality will occur first in the dark jar without rooted plants; due to the lack or oxygen production, both this mortality will begin in the jar containing the rooted plant also. This is caused by decomposition of the plant and lack of algae in the dark area. Check for temperature and pH of water in each jar each day. CAUTION: IF THE LIGHT IS TOO STRONG THE WATER MAY BECOME HOT ENOUGH TO KILL THE FISH IN THIS JAR FIRST.

Have each group check their jars closely each day starting with the second day of the activity. Have them make notes on the color of the water; the health of the plants; also the health and activity of the fish life. Note also the position of the fish life, as to surface or bottom of the jars. (Sick fish will tend to swim on the surface) note the changes each day in each jar and record these changes. Remove the dead fish. Do not remove dead plant life. Explain to the class that in a natural situation the decaying fish would give off additional carbon dioxide, thus speeding up the break down of the cycle of life.

After about 7 or 8 days the students will be aware of the break down of the chain of life due to lack of sunlight and algae.

Classroom explanation of activity.

ANY LINK IN THE CHAIN OF AQUATIC LIFE IS DEPENDENT ON ALL OTHER LINKS OF THE CHAIN. IF EVEN THE MOST MINUTE PORTION BREAKS DOWN THE ENTIRE CHAIN WILL FALTER AND DIE. THROUGHOUT THE NEXT WEEK YOU CAN WATCH THIS HAPPEN IN YOUR JARS. DO NOT ADD FOOD OF ANY KIND TO THE JARS. BE CAREFUL NOT TO PUT YOUR HANDS INTO ANY OF THE UNITS DUE TO THE CHANCE OF MOVING VERY SMALL PARTICLES OF ALGAE FROM ONE JAR TO THE OTHER. FOR A GOOD EXPERIMENT YOU NEED ONLY TO LOOK AND WRITE DOWN WHAT YOU SEE.

Teacher Direction
Page 3

DO NOT WORRY ABOUT THE MINNOWS STARVING AS THEY WOULD HAVE BEEN EATEN BY LARGER FISH, HAD THEY REMAINED IN THEIR DITCH. THROUGH THIS ACTIVITY YOU WILL SEE THAT THE SMALL UNSEEN PARTS OF OUR WATER WORLD ARE JUST AS IMPORTANT AS THE LARGEST WHALE.

QUESTIONS:

1st day	1. What do you expect to happen in jar # 1. Jar 2. Jar 3? and Jar4? and why?
	2. What are the plants for in the two jars?
2nd day	3. What food is present for the fish to eat?
	4. Does temperature or acid condition affect the fish?
	5. Why don't the fish starve?
3rd to 5th day	6. Where did the Green Scum come from?
	7. Where do the fish stay most of the time at the top or bottom of the jar?
5th to 10th day	8. Why are the fish getting "sick" in the dark jar?
	9. Why is the plant in the dark jar turning light in color?
Final Day	10. If we move the dark jars into the sunlight will these fish recover?

All jars should be retained with contents for use in a later activity.

CYCLE OF LIFE

Materials for groups of six:

1. Four--one gallon jars or small aquria.
2. Two--Babyfood jars.
3. Approx. 20 small minnows secured from a ditch or pond. (Goldfish do not work well).
4. A quantity of ditch or pond water to fill the gallon jars approx. 3/4 full.
5. Several rooted aquatic plants with enough soil remaining on roots to fill 2 babyfood jars.
6. 4 pieces of masking tape numbered 1 - 2 - 3 - and 4.
7. One Fahrenheit thermometer.
8. 10 strips of litmus paper.

Bury the roots of several plants in each babyfood jar, and place on bottom of two of the gallon jars. Fill 3/4 full of water (natural pond water if possible). Add from 5 to 10 small minnows. It is best to over stock each jar for quick results to the activity. These jars should be numbered one and three.

Place jar number one containing fish and plant life and jar number two containing fish with no plant life in the darkest area of the room (shade to semi darkness if necessary).

Then place the two remaining jars number three and four containing the exact material as above in the window where direct sunlight is abundant. (Artificial light will not work as well).

Let both units remain in the above positions without food for 5 to 7 days. You will record observations daily beginning with the second day.

You are to put down information as to what has happened each day. Record any change in any of the four jars each day. If there is no change record this also. Take the temperature of the water in all jars each day. Place a strip of blue litmus and a piece of red litmus paper in each jar and record the acid or basic condition of the water each day. If the water is acid the blue paper will appear red or pink. If the water is basic the red paper will appear blue. Does either of the above have any affect on the plant or fish life?

Record your finding for eight days, starting with the second day.

Conclusion:

1. The fish died in jars __________________ because
2. The fish did not die in jars __________ because
3. Three changes took place in jars _____ These changes were A.____________
   B.__________________________ C. __________________________
4. The main cause of the difference in the jars in the sunlight and the jars in the dark areas was what? This main difference caused what link in the chain to break down first?

STUDENT; B - 11

WATER POLLUTION

To pollute means to make unusuable. Newspapers and television are referring to pollution daily. Most of us think of a polluted stream or lake as being full of garbage, human waste, oil and other undesirable materials. Very few people would want to swim or play in a pond or lake that they could see was polluted. It is true that these things pollute a body of water; but it is what you don't see that really starts pollution. A clear stream of acid from industry, or soap from a home washing machine, or large amounts of plain tap water with too much chlorine added (the water you drink has a chemical called chlorine added to it) can kill small animals and plants called plankton and algae. These tiny bits of life are one of the major links in the chain of aquatic life and when they die the entire aquatic chain breaks down. Therefore if we continue to add these so called "harmless" agents to our rivers and streams we will soon have water with no life, or "dead rivers".

Proper treatment of waste materials by use of sewage treatment plants and chemical settling basins clean and separate these impurities out before they enter our natural rivers and streams.

You have heard of how many fish or oysters were here in the "good old days"; we now have better machines, more factories and much easier living. With these better ways of life also come waste materials and we must control these wastes in order to retain our remaining gifts of nature. If the practice of pouring wastes into our natural waters is not stopped we will soon be unable to find any fish or seafood in any of our streams including major portions of the ocean.

State and Federal laws have been made to stop this pollution but until the public starts reporting polluted areas of water we can never expect proper control. When you realize that industry and large cities are taking away a natural gift of fish and wildlife then, and only then, will you become concerned with stopping this wholesale slaughter in the underwater world.

TEACHER DIRECTION B - 12

WATER POLLUTION AND LIFE

Film: THE MARINE BIOLOGIST

Materials for groups of six: (Item 7 is necessary to complete this activity)

1. The four one gallon jars with contents intact. (Use jars that remain from B-10 cycle of life).
2. 8 Ounce of emusifiable rotenone 5% (supplied by DISCUS). Non-toxic to humans
3. Medicine dropper
4. Stirring rod (glass or wood stick)
5. Thermometer
6. Litmus paper
7. Microscope and several glass or plastic slides--one microscope can be used by all groups.

Set up the four jars containing the water used in the Cycle of Life activity. Divide the living fish equally in each jar as nearly as possible, take a drop of water from near the bottom of each jar and observe under microscope. Have students keep records of the number of living one celled plants and animals present in the drop of water. Number the notes to correspond with each jar observed. Take the pH and temperatures and record. Use the litmus paper turning pink as acid and blue as basic.

Place one drop of rotenone in jar # 1. 2 drops in jar # 2, 3 drops in jar # 3 and 4 drops in jar # 4. Take pH and temperature. Stir the rotenone until mixed well and let the jars stand for 10 minutes. Repeat observation under microscope of a drop of water from each jar and have students record the numbers and the activity of the one celled plants and animals. You will see the fish begin to react to the 4 drops of rotenone by spinning around or gasping for air at the surface. Soon they will die.

The one drop of rotenone will indicate mild pollution as may be caused by detergents and slight industrial waste.

sewage pollution where plankton are destroyed.

The three drops of rotenone will simulate advanced pollution caused by industry and a large discharge of human waste. This is the condition of our St. John's River at this time. Fish life will be affected in each of these stages.

The four drops of rotenone represents large scale pollution where all animal life is killed. This situation will prevail on our St. John's River unless control steps are taken now.

Optional: This activity can be repeated using a saturated solution of copper sulfate and the same reaction will be noted regarding plant life. Plants will not be affected by the addition of rotenone.

(note -- if conditions are such that little or no reaction is noted due to variables, double the number of drops of the chemical).

The students will observe some life in all the jars. There will be less life in the jars that were kept in the dark area, but all jars will have some living plankton and algae. As the chemicals are added and after a period of about 10 minutes the students will find dead plankton in all four jars. Fish life will not be affected in jars # 1 and 2. Jar 3 will show signs of fish mortality and jar 4 will have 100% mortality of all animal life.

Impress upon the class that pollution killed the microscopic animals, thus breaking the cycle of life long before pollution is evident to the non-professional eye. Place transparency (B-12) on the overhead during the activity.

STUDENT

B - 12

WATER POLLUTION AND LIFE

Materials for groups of six:

1. Four one gallon jars of water used in last activity
2. Water pollutant
3. Medicine dropper
4. Stirring rod
5. Thermometer
6. Litmus paper
7. The use of the classroom microscope with glass or plastic slides. If only one microscope is available the teacher will give each group a turn to use it.

Place the four jars in order with numbers 1, #2, #3, and #4 from left to right. Place the same number of minnows in each jar.

Take a drop of water with your medicine dropper from near the bottom of jar #1. Place this drop on a slide and observe under the microscope. Move the slide to three different positions and record the total number of living animals you see. Repeat this from jars #2, #3, and #4. Keep good records on the data sheets provided. Now take the temperature and find out if the water is acid or basic. Use the litmus paper to determine this. Dip a strip of blue paper into the jar, now dip a strip of red. Remove the paper and notice the color. If the blue color turns pink or red the water is acid; if the red paper turns blue the water is basic. These conditions can affect the results of pollution. Make notes on the chart provided.

Place one drop of pollution in jar #1. 2 drops in jar #2. 3 drops in jar #3 and 4 drops in jar #4. Stir each jar to mix the chemical with the water. Allow the jars to stand undisturbed for about 10 minutes.

Repeat your temperature and acid-base, check and record the results. Label your findings "after chemical is added."

After the waiting period take a drop of water from each jar and look at it under the microscope. Record the number of animals seen and the fact that they are dead or alive. Note the change of conditions in each jar carefully.

Jar # 1, represents mild pollution such as may be caused by soap and light industrial wastes.

Jar # 2, represents advanced industrial waste material and human sewage.

Jar # 3, represents advanced pollution caused by industry and large cities. This jar is in about the condition of the St. John's River, now.

Jar # 4, represents advanced pollution beyond the control measures in use today.

Notice your picture of zoo-plankton on the screen as you hunt for these animals under the microscope.

Any unusual activity of the fish should be recorded. After all jars have been observed before and after addition of the pollutant you can determine the affect of water pollution in most stages.

Information to Record	Jar #1	Jar #2	Jar #3	Jar #4
Temperature of untreated jars				
Temperature of jar after pollutant is added				
Acid or Basic condition untreated				
Acid or Basic condition after pollutant is added				
Number of living plankton before treatment				
Number of living plankton after treatment				
Number of live minnows before treatment				
Number of live minnows after treatment				
Did any fish die? If so, how many?				
Did any plankton die? If so, how many?				

TYPES OF AQUATIC LIFE

Life as we understand it above water is made up of insects, plants, and animals. Below the surface, of our lakes and oceans the waters teem with life. We have millions of plants as we do on the land, but most of these plants have no roots to hold them in one place. They are called "free floating" and are carried to all areas of a body of water by the wind and liquid currents. This group of plants is largely made up of the group too small to be seen with our eyes. They are called algae. They are like our trees and grass in that they too are green. Without these plants there could be no animal life in the sea or on land. These tiny plants produce most of our oxygen which is so necessary for animal life. Other types of aquatic plant life consist of rooted weeds, moss and larger free floating plants. These serve the same purpose as the algae with an additional function of serving as hiding places for animal life in this underwater world.

The second group of living things in this submarine world are the animals that have no backbone or bone like skeleton. These animals are called invertebrates or "with no backbone." The jellyfish, octopus, worms, squids, crabs, crawfish and shrimp are some examples of this type of life. Most of these animals serve the purpose of keeping the water clean. They eat other dead and decaying animals and plants. Microscopic animals called zoo-plankton are also members of this group.

The third and best known types of life in the sea is made up of complex animals with many working parts. All of these animals have "backbones" and we call them vertebrates "with spinal chords". The whales, dolphin(porpose), and all of the fish belong to this group. The function of these vertebrates is to eat the millions of tiny invertebrates, thus completing the chain of life that we will discuss next.

TEACHER DIRECTION

B - 14

GROUPING

Materials:

1. Varied shapes cut out
2. Overhead projector

As we begin to look at the many varied forms of life one is impressed with the need for some type of classification (grouping) to bring some orderliness to this great variety of organisms.

The method of grouping will depend on the object or organism to be grouped and also on the individual doing the grouping. In order to illustrate this, cut out the following shapes and place them on the overhead projector. Ask the class to group them. Move them around as different members of the class suggest.

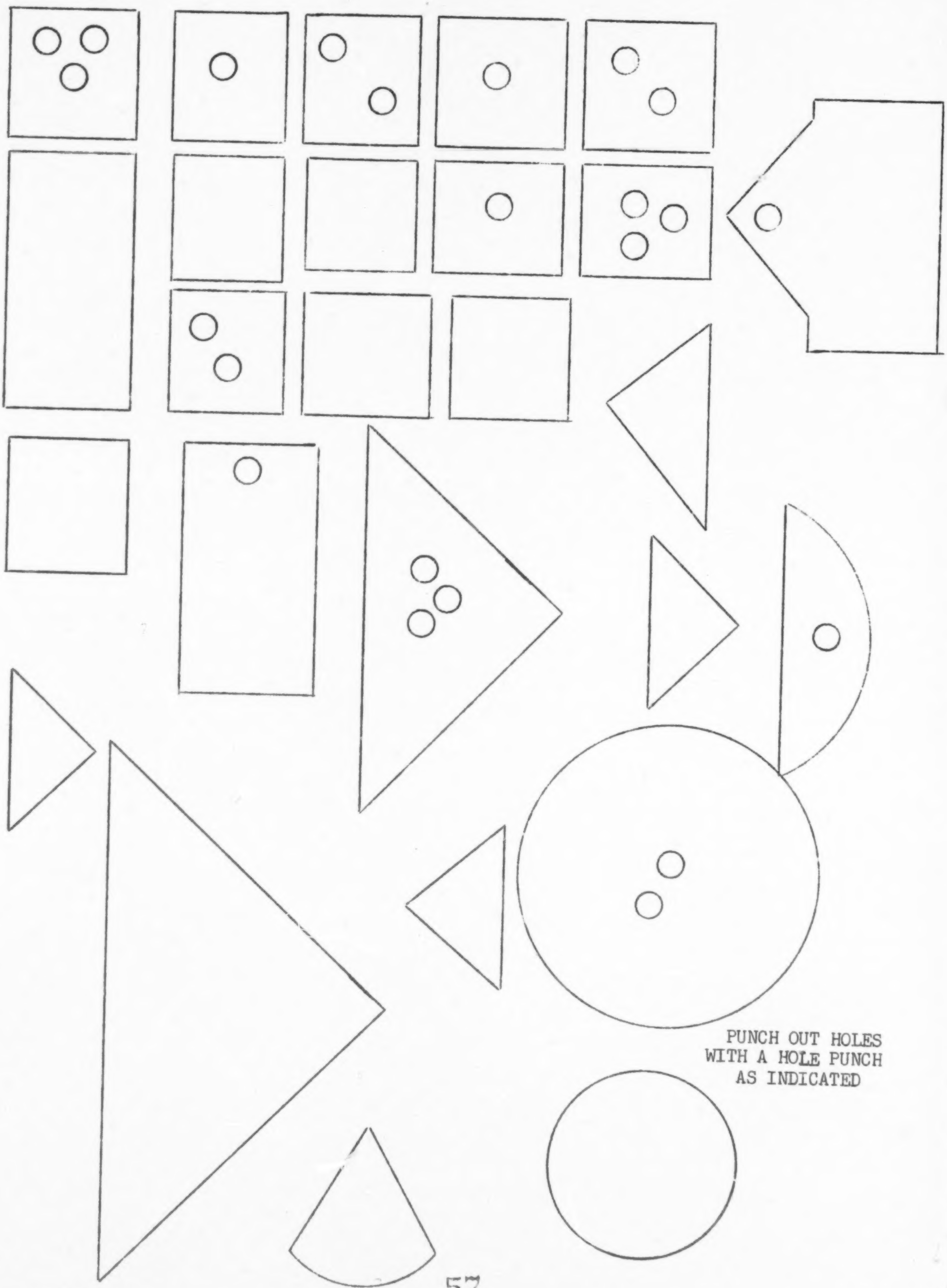
It should soon become apparent that some of the shapes can go into more than one group. Some suggested groups to start the class with would be triangles, circles and rectangles. Allow students to present their argument for placing a shape in a particular group. If classmates wish to challenge allow this and then try to come to a class consensus as to which is the best grouping, all points considered. This situation is similar to that the scientist faces in grouping plant and animal life. Some organisms have characteristics of both (Euglena). Even the simple grouping of living and non-living is a difficult task for example the Virus.

Students should be reminded of the many things we group daily and asked to add others:

For example:

1. How many different ways can we group cars?
2. How many different ways can we group teachers?
3. How are items grouped in a grocery store?

TEACHER DIRECTION B - 14



PUNCH OUT HOLES
WITH A HOLE PUNCH
AS INDICATED

TEACHER DIRECTION B - 15

IDENTIFICATION OF FISHES

Film: WHAT IS A FISH
THE SEA ZOO
UNDERSEA LIFE

Materials:

1. Transparencies for fish identification

This activity is entirely teacher directed. Students should be allowed time to read the reading activity and to view the suggested films that are available. A series of four transparencies on the different types of fish has been prepared. The narrative to be read with each transparency begins on page 43.in the teacher handbook. After reading the narratives and discussing each transparency. Go back and ask the class to name as many of the fish from the transparency as possible.

IDENTIFICATION OF FISHES

To most of you one fish probably looks just like another. You will be surprised to know that in Duval County alone there are almost 100 different kinds of fresh water fish and nearly 500 different salt water types that live here most of the year. We will not attempt to recognize all of these.

The most common fish are those we catch while fishing with hook and line. If you can learn to identify these you will have a good start into Marine Science.

You have learned that carnivorous fish, are fish that eat other living fish. Many of the fish sought after by the sports fisherman fall into this group. The red bass, speckled trout, flounder, king mackerel, sailfish and snapper are all carnivorous. The mullet, croaker, sheepshead and spot are called forage fish. These fish feed on crustaceans that we described as "insects of the sea", they also eat parts of dead fish and many of the aquatic plants.

A picture of these fish will be projected on the screen, pay close attention to the shape of the body, the shape, location, and size of the mouth and the construction of the jaws. The type of teeth usually will tell what type of fish we are trying to classify. If the teeth are sharp or long we can almost be sure that they are used to catch, cut up, or hold other living fish. If they are small or of the type that crush food, or if they are not present at all, we can usually class this fish as forage. There are exceptions such as the black bass and tarpon, the sailfish and marlin or the sheepshead. These types have to be studied as to their habits before we can be sure of the proper classification.

The marlin and sailfish have extended upper jaws or bills. These bills are used as weapons to kill their live food. Since these fish have no teeth to grasp or cut their food, the bills are necessary for them to feed.

The tarpon and black bass have no sharp teeth to cut or grasp their food but they have extra large mouth openings that can engulf or completely enclose their food in one gulp.

The sheepshead is different from the above carnivorous fish, in that he is a forage fish that feeds on food other than living fish. He has teeth similar to your front teeth and they are used the same as you use yours to bite corn off the cob. The prime diet of the sheepshead is the barnacle. Barnacles are small shellfish with hard outer skeletons that cling to posts and docks in salt water. The sheepshead scrapes these shellfish off the pilings and crushes the shell and then eats the meat of these crustaceans. This is an example of a forage fish that is equipped with the large sharp teeth of a carnivorous type, while his feeding habits are those of a true forage fish. You can see now that there are exceptions to all of the rules of classification of fishes, as well as all other life forms.

The pictures flashed on the screen will show you an example of several types of forage and carnivorous fish. There are many other ways to classify fish other than the type of mouth and teeth. One of the more important methods is body shape and type of scales. Fish such as the shark and ray have scales that are constructed much like your teeth in that they have an outer coating of enamel and are imbedded in the skin. The Bass family has scales with sharp saw-like edges. The suckers and minnows have overlapping scales with smooth edges. The garfish has an armor of diamond shaped scales that has protected his kind for almost a million years. The catfish family has no scales at all. We can now see that fish may also be grouped according to their different kinds of scales.

The body shape of fish can also be used to classify fish. The eel's body is shaped like a snake. The bream or sheepshead's body is flat and shaped like the hull of a boat. The flounder's body is flat and wide. These body shapes aid the fish in swimming and feeding as well as hiding from larger fish; but each type has a body shape special to his class. We can separate fish into body shapes to help classify them as to names and families.

Student
page 3

The location and structure of fins plays a large part in dividing the families of fish. When using fins to group fishes, you will immediately think of the sailfish with his extra large dorsal (fin on top of the body) fin. If we put this large fin and his long upper jaw or bill together, he fits into the billfish group and thus into the sailfish family and cannot be confused with any other fish.

TEACHER DISCUSSION OF FISH CLASSIFICATION RELATED TO OVERHEAD PROJECTIONS:

TRANSPARENCY # 1

These are forage fish that eat food other than living fish.

THE CHANNEL CATFISH IS ONE OF THIS GROUP THAT FEEDS MAINLY ON FRESH WATER INSECT LIFE UNTIL HE REACHES AN AGE OF ABOUT 2 YEARS AND SEVERAL POUNDS IN WEIGHT. HE THEN CHANGES IN OUTWARD APPEARANCE FROM A LIGHT BLUE SPOTTED FISH TO A BLACK BIG-MOUTHED FISH THAT FEEDS SIMILAR TO THE BLACK BASS. THE CHANGE FROM FORAGE TO CARNIVOROUS FISH TAKES PLACE IN A PERIOD OF SEVERAL MONTHS. HE USUALLY LIVES TO A RIPE OLD AGE OF 20 TO 30 YEARS.

THE SHEEPSHEAD, YOU ARE FAMILIAR WITH FROM YOUR READING MATERIAL. THIS CONVICT FISH, SO CALLED BECAUSE OF HIS STRIPES HAS LARGE FRONT TEETH THAT SCRAPE BARNACLES FROM PILINGS MUCH THE SAME AS YOU EAT CORN ON THE COB. THIS SALT-WATER FISH REMAINS A FORAGE FISH ALL OF HIS 4 YEAR LIFE SPAN.

THE AMERICAN EEL IS NOT A SNAKE. HE IS ONE OF THE FEW SALT WATER-BORN FISHES THAT COME INTO FRESH WATER TO SPEND THEIR ADULT LIFE. THE EEL HAS SCALES AND IS A TRUE FISH THAT FEEDS ON INSECTS AND CRUSTACEANS AND FALLS IN THE CLASS OF FORAGE FISH. ONE WELL-KNOWN EEL IS THE ELECTRIC EEL. GO TO YOUR LIBRARY AND READ MORE ABOUT THIS STRANGE FISH.

DISCUSSION

TRANSPARENCY # 2

THESE FISH ARE REFERRED TO AS BILLFISH BECAUSE OF THE EXTENDED UPPER JAW (POINT TO BILL). THIS BILL IS USED AS A CLUB TO STUN OR KILL SMALLER FISH. THE BILL IS NOT USED AS A SPEAR TO STICK WITH AS SOME PEOPLE MAY THINK. THE OUTER SURFACE OF THE BILL IS COVERED WITH SMALL BARB-LIKE SPINES THAT TEAR AND RAKE THE FISH THAT ARE STRUCK. AFTER GOING THROUGH A SCHOOL OF FISH AND SHAKING THIS BILL FROM SIDE TO SIDE, THE BILLFISH TURNS AND EATS THE STUNNED OR DEAD BAIT FISH.

THE BROADBILL SWORDFISH WILL REACH A WEIGHT OF OVER 1,000 POUNDS AND AVERAGE WEIGHTS OF 200 TO 500 POUNDS. HIS FOOD CONSISTS OF MULLET, MACKEREL AND SMALL TUNA. HIS TOP SPEED IS NEAR 70 MILES PER HOUR. HIS HOME IS THE DEEPER PARTS OF THE OCEAN.

THE BLUE MARLIN FEEDS ALMOST EXACTLY LIKE THE SWORDFISH BUT IS MORE ABUNDANT. HE IS FOUND THROUGHOUT THE WORLD IN THE OPEN OCEAN.

THE WELL-KNOWN SAILFISH TENDS TO LIVE IN THE OCEAN NEAR SHORE AND FEEDS MAINLY ON MULLET AND SMALL MACKEREL. HIS FEEDING HABITS ARE MUCH LIKE THE MARLIN AND SWORDFISH BUT HE DOES NOT REACH NEARLY THE WEIGHT OF THESE OTHER MEMBERS OF THE BILLFISH FAMILY.

TRANSPARENCY # 3

This group of fish is the type that has no sharp cutting teeth but have mouths large enough to completely engulf live fish used as food. These fish are all carnivorous. The small fish caught are swallowed alive.

The "speckled perch" the Florida name for black crappie, is a fresh water fish enhabiting most of the waters of Florida. He feeds mostly on small minnows and the young of all fresh-water fish. He is carnivorous and grows to the ripe old age of about 3 years. He then dies of old age and sinks to the bottom to become fertilizer.

The black bass, Florida's most valuable fish, inhabits all fresh water of the State. The State has placed a value of $5 per pound on this fish. This means that fishermen, both tourist and resident spend about $5 per pound of fish caught on tackle, transportation, boats and motors, lodging and food. This makes us wonder if oranges or Bass are more important to the economy of Florida.

The tarpon, or Silver King as he is called is a salt-water fish that is really an overgrown sardine. He is a member of the same family that the sardine belongs to. The two main factors that place the tarpon in a different group is the fact that he is carnivorous and attains a size of several hundred pounds. His smaller relative, the sardine, struggles to reach 2 ounces and feeds entirely on plankton.

TRANSPARENCY # 4

These fish are all carnivorous. The snook inhabits the salt and "brackish" waters (brackish means salt and fresh water mixed) of South Florida. They feed almost entirely on mullet and attain weights of twenty to thirty pounds. In addition to a very large mouth, this fish has a knife-like plate attached to each gill cover. These "knives" are used to slash and cut through a school of small fish allowing the snook to return and feed more slowly. The snook has a broad dark line down each side. This is called his lateral line and is made up of many small nerves that serve as ears for the fish. All fish are equipped with this lateral line.

The red bass is the local name for channel bass. They belong to the croaker family but unlike the shrimp-eating croaker the red bass is carnivorous and prefers live fish as his diet. The range of this bass is inshore salt waters and the surf areas of our beaches. This fish reaches sizes of 40 to 60 pounds but the average weight is about 10 pounds.

The speckled trout is also a carnivorous fish equipped with long sharp teeth used in catching and holding smaller fish. This trout attains a size of about 15 pounds but usually averages about 2 or 3 pounds. Most of his life is spent in the creeks and grass flats of our salt water areas. A close relative of this fish is the Yellowmouth trout or more properly called the northern weakfish.

B - 16

GREEN-GREEN

Wherever we go we see green plants. In places where the temperature, rainfall, light and soil are just right, a thick growth of vegetation covers the earth. Even in crowded cities there are many places where green plants can live. Though water is very scarce in deserts, many kinds of green plants are able to grow there.

Great numbers of green plants live in the ocean. Some of these are among the largest plants known. Certain kinds of kelp that grow in the Pacific Ocean reach a length of over 600 feet. Ships are unable to sail through some parts of the ocean because of the thick growth of gulfweed. The roots of water plants are usually poorly developed, because such plants are able to obtain water very easily.

Desert plants usually have well developed root systems. The roots of some desert plants extend downward for more than one hundred feet and in this way obtain enough water for the growth of the plant. The top parts of most desert plants have a think covering. This keeps the water within the plants from escaping into the air.

In many places near the equator it rains every day. This large amount of moisture, together with the high temperature, results in a thick growth of plant life called a rain forest. In a rain forest the trees are very tall, and their branches spread out thickly at the top. Sometimes the branches are so close together that they shut out nearly all the light from the smaller plants that grow underneath. The air under this roof of branches becomes very moist. Many strange plants, such as orchids, grow on the ground and on the trunks of the trees. Some orchids have roots that obtain water from the moist air.

In the far north, it is so cold that the ground freezes to a depth of many feet. In artic regions, the heat of the summer sun is able to thaw out soil to a depth of only a few inches. Even under these conditions, there is often a thick growth of green plants called a tundra. The roots of these tundra plants obtain plenty of moisture from the melting ice in the soil. They also grow rapidly during the short summers for at this time there is plenty of sunlight.

Green plants have spread over almost the whole surface of the earth. There are very few places where they cannot be found at some time during the year. Along the seashore, in rivers and lakes, on land, in the oceans and even at the tops of high mountains, we see their familiar green color. In order to live, green plants seem to require only five things: water, light, air, minerals, and a suitable temperature for growth.

TEACHER DIRECTION B - 17

GROUPING LEAVES

FILM: Trees and How We Identify Them

Materials for groups of three:

1. Large number of leaf types collected from field trip
2. Old newspapers to be used as blotters
3. Can spray paint, or wire screen, toothbrush and bottle of ink
4. Glue or paste
5. Weights (clean bricks will do)

Two objectives should be achieved in this activity. Students should come to know by common name the different trees and shrubs in their immediate surroundings and the sheer enjoyment of preparing the labeling of the prints.

If student interest is such, students should collect additional leaves at home or in other localities and bring them to class for preparation.

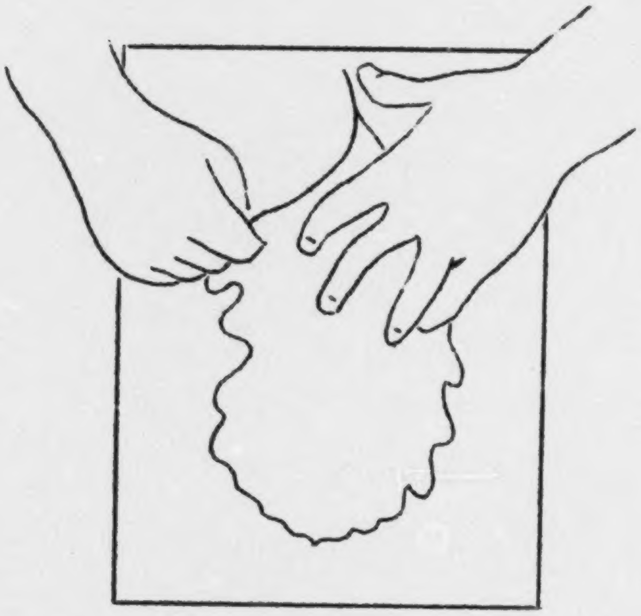
The least expensive method of preparation is to use a wire screen with an old toothbrush and a bottle of ink. (See diagram) For variation students may use many different colors of ink. In the classification of the leaves, students should include common name, type of leaf: simple, compound, toothed, etc. and the general location of where the leaf was found.

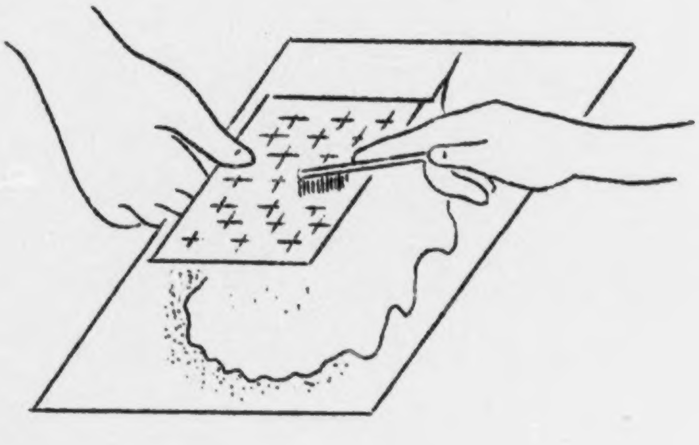
Use the transparency to show different leaf types for example, as to margin, smooth, lobed, toothed, or as to type of veins: palmate, pinnate, or parallel, simple or compound.

After the students have made prints, have them find how many different ways they can group the leaves: size, shape, margin, veins.

A transparency is provided with the picture of the leaves of four common North Florida trees. This transparency may be used as a test at the end of the activity or a review as you desire.

PREPARATION OF LEAF PRINTS





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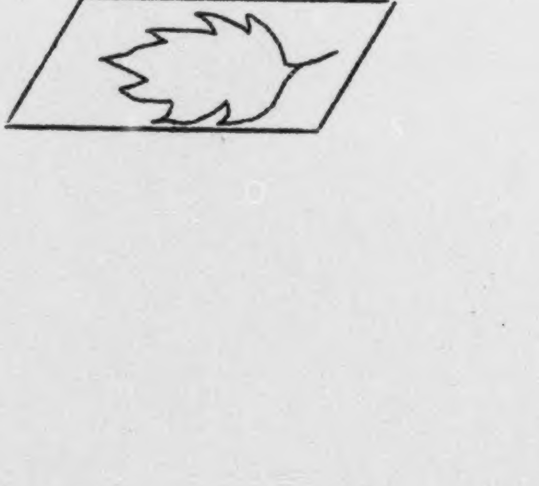

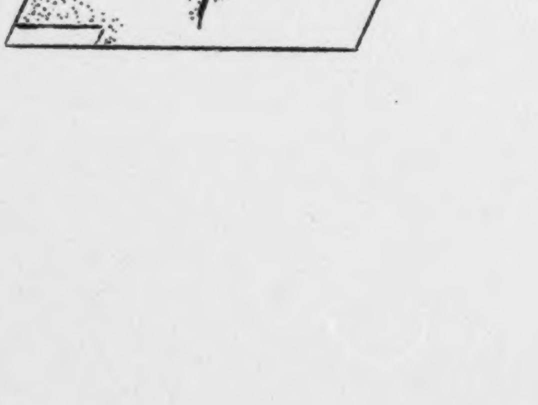

STUDENT

B - 17

GROUPING LEAVES

Materials for groups of three:

1. Large number of leaf types collected from field trip
2. Old newspapers to be used as blotters
3. Can spray paint or wire screen, toothbrush and bottle of ink
4. Glue and paste
5. Weights (clean bricks will do)

Leaves are easily grouped as to simple or compound arrangement. They can also be grouped according to margins that are lobed or unlobed with entire margins or toothed margins. They can also be grouped as to whether the pattern of the veins is parallel or in net-like patterns.

Place each leaf between newspaper which is at least two sheets thick. Allow these to remain under pressure of the weights for 2 to 3 days. Sometimes a week is required to dry semi-succulent leaves as well as succulent leaves. This can be started one week and finished the next. After the leaves are dry, remove them and make spatterprints for each leaf collected. The instructor will demonstrate how this is done. Each leaf should at least be identified by its common name. How many different ways can you group them?

QUESTIONS:

1. How many different kinds of compound leaves can you find?
2. Are any of the compound leaves toothed?
3. Do some of the lobed leaves look different?
4. How many kinds of lobed leaves look different?
5. How many kinds of lobed leaves are present?
6. Name some leaves which have their veins in a parallel pattern.
7. Name some plants which have their veins arranged in a net-like pattern.

KEY TO TRANSPARENCY B-17, B-18

LEAVES

1. Live oak
2. Black gum
3. Laurel oak
4. Myrtle oak
5. Southern red oak
6. Turkey oak
7. Water oak
8. Post oak
9. Persimmon
10. Tulip tree
11. Sweet gum
12. River birch
13. Fringe tree
14. Pecan
15. Southern magnolia
16. Sweet bay
17. Dwarf banana

A. Magnolia
B. Live oak
C. White ash
D. Sycamore
E. Willow
F. Plum
G. Cherry
H. Hickory

1. Sycamore
2. Live oak
3. Willow
4. Plum

1. Cockroach
2. June bug
3. Walking stick
4. Gaint water bug

INSECTS

A. Green Stinkbug
B. Mole cricket
C. Rhinoceros bettle
D. Stag bettle
E. Ox bettle
F. Horn bettle
G. American cockroach
H. Unicorn bettle

1. Mosquito
2. Katydid
3. Black ant
4. Landy bird
5. Caterpillar catcher
6. Dragonfly
7. Daddy longlegs
8. June bug
9. Paper wasp
10. House fly
11. Cricket
12. Potato bug
13. Giant water bug
14. Walking stick

B - 18

INSECT COLLECTIONS

TEACHER RESOURCE

Every school should have a collection of insects as a part of its permanent teaching equipment. It may not be possible for the teacher to make a very complete collection in a single year, but over a period of years it is possible to accumulate a very sizeable one. In this activity, students will be encouraged to collect and mount insects and the better ones obtained may be made a part of the permanent school collection.

In this activity, let one group specialize on beetles, another on butterflies, another on moths, etc. During September adult insects are abundant and easily collected. Some collecting should be done during class time and some on student time. Open fields or parks will provide an excellent source of specimens.

Collecting:

Killing jars may be made by using wide-mouth pint jars with cotton attached to the inside of the lid with masking tape. Either carbon tetrachloride or chloroform can then be placed on the cotton, the insect placed in the bottle, and the lid secured tightly.

In addition to killing jars, it is a good idea to take along several bottles of 80% alcohol in which to place soft-bodied insects: caterpillars, insect larva, et al. Small plastic medicine vials or baby food jars may be used for the final mounting.

Mounting:

Insects collected in the field should be mounted the day after they are collected. If they are kept in a tightly closed jar, they will remain relaxed for a day. Cigar boxes do well as pinning boxes. Place in the bottom of the box a layer of soft balsa wood or pressed cork. Corrugated cardboard may also be used. Special insect pins, size number three, should be used, but regular straight pins may be used if the others are not available.

B - 18

INSECT COLLECTIONS

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Killing jars may be made by using wide-mouth pint jars with cotton attached to the inside of the lid with masking tape. Either carbon tetrachloride or chloroform can then be placed on the cotton, the insect placed in the bottle, and the lid secured tightly.

In addition to killing jars, it is a good idea to take along several bottles of 80% alcohol in which to place soft-bodied insects: caterpillars, insect larva, et al. Small plastic medicine vials or baby food jars may be used for the final mounting.

Mounting:

Insects collected in the field should be mounted the day after they are collected. If they are kept in a tightly closed jar, they will remain relaxed for a day. Cigar boxes do well as pinning boxes. Place in the bottom of the box a layer of soft balsa wood or pressed cork. Corrugated cardboard may also be used. Special insect pins, size number three, should be used, but regular straight pins may be used if the others are not available.

Students should make labels as small as possible and supply the following information:

The locality Date Name of Collector

The label should be on the pin below the specimen. Specimens in vials should be labeled with the same information.

A simple method to relax dried insects such as butterflies, moths, etc., is to place the insect in a petri dish, with a steam iron placed over the open dish to emit steam directly onto the specimen. The steam will permeate through the insect and thoroughly relax it in just a few minutes. After the collection is completed, it should be protected by using moth crystals every three months.

A good reference book for teacher and student use in classifying and naming captured insects is Insects by Herbert S. Zim, Ph.D. and Clarence Cottam, Ph.D. This book is available in paper back form.

TEACHER DIRECTION

B - 18

INSECT COLLECTION

FILM: Insect Mounting and Preserving

Materials for groups of three:

1. Killing jar
2. Mounting pins
3. Cotton
4. Killing solution
5. Collection jars
6. Forceps

TODAY WE ARE GOING OUTSIDE, THIS TIME TO COLLECT INSECTS. YOU WILL AGAIN WORK IN YOUR GROUPS OF THREE. ONE MEMBER OF EACH GROUP SHOULD SERVE AS COLLECTOR AND THE OTHER TWO MEMBERS SHOULD SERVE AS SCOUTS TO FIND THE INSECTS AND BRING THEM TO THE COLLECTOR. BE CAREFUL IN PICKING UP THE DIFFERENT SPECIMENS AND ALWAYS USE FORCEPS TO PREVENT INJURY FROM STINGING INSECTS.

AFTER WE RETURN TO THE ROOM, WE WILL TRY TO IDENTIFY AND MOUNT ALL THE DIFFERENT SPECIMENS. AGAIN LET ME REMIND YOU THAT YOU ARE TO REMAIN WITH THE CLASS SO YOU CAN HEAR ANY DIRECTIONS SO DO NOT WANDER OFF IN ALL DIRECTIONS.

BEFORE WE LEAVE, LET'S READ OVER THE INSTRUCTIONS TOGETHER.

Pass out B-18 and read over it with the class and answer any questions students may have.

Insects collected should be mounted the following day. Have students determine the best method for grouping their collection. Hopefully they should arrive at a grouping similar to the insect orders, but if they have another method that they can defend, allow them to group on that basis.

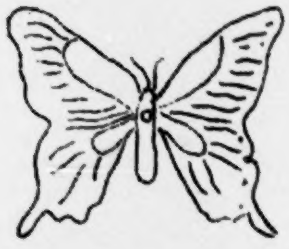
STUDENT

B - 18

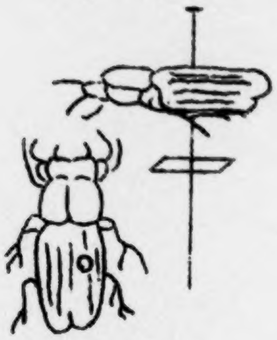
INSECT COLLECTION

Materials for groups of three:

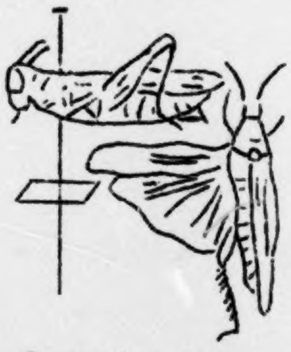
1. Killing jar
2. Mounting pins
3. Cotton
4. Killing solution - Carbon Tetrachloride
5. Collection jars



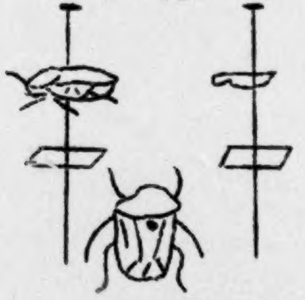
Butterflies



Large Beetles



Grasshoppers



Bugs

Mounting Small Insects

Today we will be working with one of the largest and most interesting groups of animals on earth, the insects. This group of animals is so large that no one knows how many different kinds actually exist, since all of them have not been classified. It is estimated that there are over eighteen times as many different species as the entire group of animals that have backbones.

Be sure and follow the directions of your instructor as to how to kill and mount the different specimens. Perhaps you would like to continue your collecting at home. Many insects, particularly beetles, can be found by moving stones or sticks or by digging them out of rotten logs. Flying insects may be captured at rest, or in flight using an insect net.

Notice the diagram and follow it for pinning and mounting captured insects.

LET'S RECORD WHAT YOU SEE:

1. How many legs does each of your insects have?
2. What difference can you see between the beetles and the bugs?
3. What is unusual about the eyes of the insects?

TEACHER DIRECTION

B - 19

RANDOM SAMPLING

Materials for groups of three:

1. 1-foot wire squares
2. Table to record data on

This activity should be started with the question IF WE WANTED TO KNOW HOW MANY PLANTS OF A PARTICULAR KIND ARE ON THE FOOTBALL FIELD, HOW COULD WE FIND OUT?

At first, students will probably answer, count them. Point out that it would be very difficult if not impossible to count each individual plant when there are so many and since the area is so large.

A SAMPLING DEVICE MAY BE MADE OF ANY LIGHT WIRE AND SHOULD BE FORMED INTO A ONE-FOOT SQUARE. EACH GROUP SHOULD THROW THE SAMPLING DEVICE TEN TIMES BEING CAREFUL TO RECORD THE NUMBER OF PLANTS INSIDE THE SQUARE INCLUDING ANY PARTIALLY IN THE HOOP. FROM THESE FIGURES AN AVERAGE SHOULD BE TAKEN FOR THE GROUP AND THEN THE AVERAGE FOR ALL OF THE GROUPS.

The area for the field may be figured and this figure multiplied by the average number of plants per square foot to give the approximate number of plants in the entire area.

Seed stalks of Bahia grass in this area make excellent examples to sample. If these are not available, other plants will work equally well: dandelions, clover, sandspurs, etc.

RANDOM SAMPLING

Materials for groups of three:

1. 1-foot wire square
2. Clip board and tablet
3. Football field, square lawn, or ball diamond

A population may be defined as the number of one kind of organism in a certain area. The size of a population depends on the number of organisms in the area and the size of the area. If a large number of the same organism is present in an area, it is said that the area has a high population density. If very few of the same kind of organism is present in an area, it is said that the area has a low population density.

Close your eyes and gently throw the wire square over your shoulder. Do not look for a place to throw it, and do not pick a place and aim for it. The throw must be made entirely without looking.

Count each plant in the 1-foot square. Do not count each individual blade of grass. Repeat the count one more time and add all of the counts from each group of students together. Divide this by the total number of throws to obtain an average number of plants per square foot.

Calculate the area of the field chosen for sampling, and after the area in square feet is obtained, multiply by the average number of plants per square foot. This will give an answer which will be the approximate population of the field. Grass plants, sandspurs, dandelions, will work well but other plants can be used.

The easiest field to sample is a square field. This can be obtained by marking the boundaries with a string. The formula for the area is $A = S^2$. A rectangular field works equally well. Here, the formula is $A = LW$.

AFTER EACH THROW, RECORD THE NUMBER OF PLANTS ON THE CHART ON THE FOLLOWING PAGE.

OUR GROUP		OTHER CLASS GROUPS	
Throw Number	Number of Plants	Group Number	Average Number of Plants
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	
TOTAL*			

DIVIDE EACH TOTAL BY 10 IN ORDER TO FIND THE AVERAGE FOR YOUR GROUP AND THEN THE ENTIRE CLASS.

UNIT 3

ENERGY PROCESSES

UNIT III

ENERGY PROCESSES

Living systems are dependent on energy. This energy may be obtained from numerous sources and in various ways. In this series of activities an attempt is made to relate the many different forms of energy production to living systems. Beginning with a burning candle and progressing to the complex process of photosynthesis in plants and digestion in man.

The activities included in Unit III are:

B-20	BURNING A CANDLE FILM: SOLIDS LIGUIDS, GASES FIRE: WHAT MAKES IT BURN
B-21	CARBON DIOXIDE
B-22	OXYGEN
B-23	CARBON DIOXIDE AND GREEN PLANTS
B-24	OXYGEN AND THE GREEN PLANT
B-25	DIFFUSION
B-26	EXPERIMENTS WITH GREEN PLANTS
B-27	EFFECTS OF SUNLIGHT ON PLANTS
B-28	CHROMATOGRAPHY (Color separation)
B-29	CHLOROPHYLL REMOVAL
B-30	RED PIGMENT REMOVAL
B-31	YELLOW PIGMENT REMOVAL
B-32	PRODUCTS OF BURNING
B-33	LUNG CAPACITY
B-34	RESPIRATION IN MAN

B-35	CARBON DIOXIDE RELEASE BY PLANTS
B-36	DO PLANTS NEED FOOD
B-37	FOOD TEST FOR SIMPLE SUGARS
B-38	PROTEINS
B-39	CARBOHYDRATES
B-40	FATS
B-31	CALORIES
B-42	CALORIE COUNTING
B-43	BEGINNING OF DIGESTION

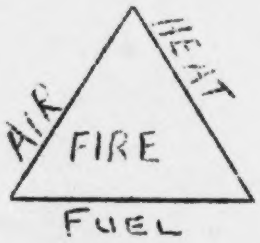
TEACHER DIRECTION B - 20

BURNING A CANDLE

Materials for groups of three:

1. Candle
2. Gas bottle
3. Bromothmol Blue
4. Matches
5. Cork
6. 2"x2" Glass Square

Explain the basic principles of burning to the students using transparency B-20. A fuel, some oxygen and heat are the requirements. Gases are the products.



BURNING IS A CHEMICAL REACTION. THIS MEANS THAT THE OBJECT BURNED IS CHANGED AND CANNOT BE RETURNED TO ITS ORIGINAL FORM. LET'S FIND OUT WHAT NEW PRODUCTS ARE FORMED WHEN AN OBJECT BURNS. Pass out B-20

Show how to set up the equipment for the first part of the activity. Have students place a few drops of wax on a sheet of paper and then secure the candle in this fresh wax. When they remove the bottle from the candle after it has burned out, tell them to be careful not to let too much air in the bottle as they relight the candle. Placing a glass square over the mouth of the bottle will keep out air.

The success of this series of activities related to burning depends on an understanding of the reaction of bromthymol blue

Teacher Direction
page 2

which serves as an indicator. Bromthymol is blue in basic solutions (absence of carbon dioxide) and yellow in acid solutions (carbon dioxide present). Have some students blow through a straw into some bromthymol blue to show this color change.

In this activity you will have to add about 2 ml of water to each test tube of collected gas before you get a positive reaction.

TODAY YOU WILL USE A CHEMICAL CALLED BROMTHYMOL BLUE. IT IS CALLED BLUE BECAUSE IT IS USUALLY BLUE. HOWEVER IT WILL CHANGE COLORS (blow your breath into a test tube containing bromthymol blue using a soda straw. This will demonstrate the color change). NOW WHAT COLOR DO WE HAVE? WHAT MADE THE BROMTHYMOL CHANGE COLOR? BAD BREATH? NO, CARBON DIOXIDE. IF WE COULD TAKE THIS CARBON DIOXIDE OUT MAYBE IT WOULD CHANGE BACK.

Show the transparency again and fill in the last half of the equation.

THE COMPLETED FORMULA SHOULD SHOW:

GENERAL FORMULA	FUEL +	OXYGEN +	STARTER =	CARBON DIOXIDE +	WATER +	ENERGY
	Candle	Air	Match	Smoke	Water	Heat Light

STUDENT B - 20

BURNING A CANDLE

FILM: SOLIDS, LIQUIDS, GASES
FIRE: What makes it burn

Materials for groups of three:

1. Candle
2. Gas bottle
3. Box matches
4. Cork for test tube
5. Bromthymol blue
6. 2"x2" glass square

When we burn something, we need certain things. First of all, we need a material that will burn. This is our fuel. Next, we need oxygen and, of course, enough heat to start the burning. This is our starter. Burning will cause our fuel to change and new materials will be formed. What new materials will be formed? Let's examine a burning object and see what is happening. We will use a candle as our fuel.

Take a candle and light it with a match. Drop a few drops of wax on a sheet of paper and stick the candle in place. Now take the gas bottle and place it over the candle. Does it burn? ____________________ How long did it burn? __________________________ Why? __________________ How long did it take for the candle to go out? (Time) ______________ Now vary the size of the bottle using one larger and one smaller. How does the size of the bottle effect the length of time the candle will burn? ___________________________ Lift the bottle carefully, light the candle again, and quickly place the bottle over the candle again. Does the candle burn? ________________ Why or why not? ________________________________

So far, we have learned that: a candle (fuel) + air (oxygen) + a burning match (heat) = a burning candle (flame). Now let's see what new materials are formed as the candle burns.

Take the burning candle and hold your hand a few inches above the flame. Do you feel any heat? _____________. What is heat? ___________________________ What other type of energy is the candle giving off? ____________________________________.

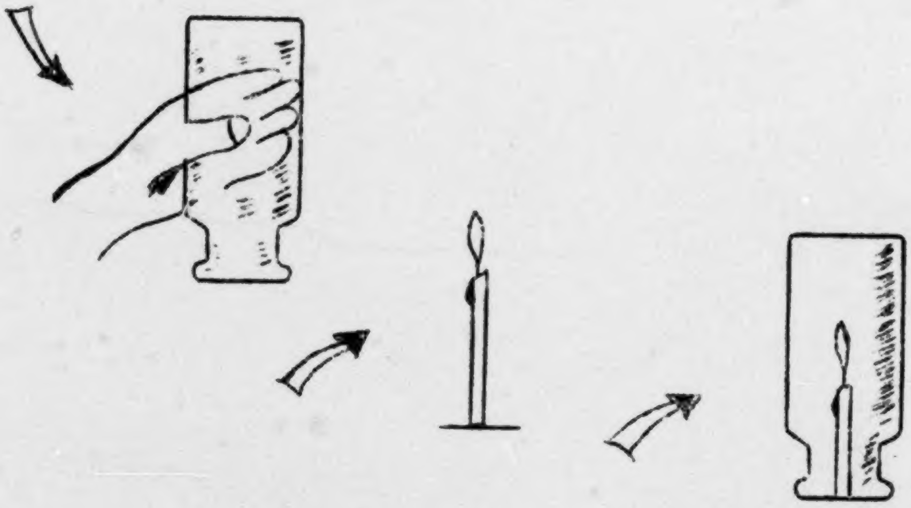
If you look above the candle flame, you can see smoke. Smoke is made up of what? _______________________ To see what gases are in the smoke, let's collect some of the smoke. Hold a bottle with the open end just above the flame. After a few minutes, place a glass square over the mouth of the bottle. We will test the smoke with bromthymol blue. Can you see any smoke inside of the bottle? _______________________ Any moisture? ___________ Bromthymol blue will show the presence of carbon dioxide.

Add two drops of bromthymol blue and 5 ml water to the gas bottle with the smoke. What happens? ________________ What gas would you say is present in the smoke? ____________________ What color will bromthymol blue turn if carbon dioxide is present.

Take the candle again and hold another gas bottle over the flame. Look at the sides of the bottle. Do you see any drops of water? _______________________

What are the new products being formed? ____________________

General Formula	Fuel +	Oxygen +	Starter	Carbon =Dioxide +	Water +	Energy



TEACHER RESOURCE

In the next two activities we shall try to get students to recognize some of the physical properties of two of the gases so important in burning and in photosynthesis and respiration, carbon dioxide and oxygen.

Carbon dioxide comprises only 0.04% of the atmosphere by volume. Large amounts of this gas are dissolved in the rivers, lakes, streams, and oceans of the world. This gas is produced by the decay of living matter, and is one of the gases given off by active volcanoes, by burning materials that contain carbon, and by exhaling in animals and man. The gas itself is colorless and is a heavy gas, causing it to be found in great abundance in the lower levels of the atmosphere. The gas can be solidified into a form commonly known as "dry ice" by lowering its temperature to -78°C its freezing point. It is also a major constituent of all carbonated drinks. Carbon dioxide does not support burning and therefore is used in many different types of fire extinguishers.

Oxygen accounts for 20% of the earth's atmosphere and is a colorless, odorless, and tasteless gas. This gas is slightly heavier than air and it too, is found in lower levels of the atmosphere. Large amounts of oxygen, like carbon dioxide, are found dissolved in rivers, lakes, streams, and oceans of the world where it is a necessity for sustaining life for most of the living organisms that inhabit these waters.

Oxygen may be compressed into a liquid form, since it does support burning, "liquid oxygen" is used in large quantities in this country's space program, both as air for astronauts and to supply needed oxygen for the burning rocket fuel.

TEACHER DIRECTION B - 21

CARBON DIOXIDE

Materials for groups of three:

1. Gas Bottle
2. Thistle Tube
3. Baking Soda
4. Vinegar
5. 4 Test Tubes
6. 4 Solid Stoppers #3
7. Beaker
8. Rubber Tubing
9. Bromthymol Blue
10. 2 hole stopper # 6½
11. "L" shape glass tube
12. Spoon

TODAY WE WANT TO MAKE ONE OF THE GASES SO IMPORTANT TO LIVING ORGANISMS, CARBON DIOXIDE. WHERE DOES CARBON DIOXIDE COME FROM? (Pause for class response, write these on an acetate. Mention any others the students omit. They will probably know carbon dioxide is exhaled by man.)

WHAT DOES THIS GAS LOOK LIKE? WHAT DOES IT TASTE LIKE? LET'S MAKE SOME AND TEST IT.

Pass out B-21

You may want to produce some carbon dioxide using dry ice. The gas may again be collected by using water displacement.

STUDENT B - 21

CARBON DIOXIDE

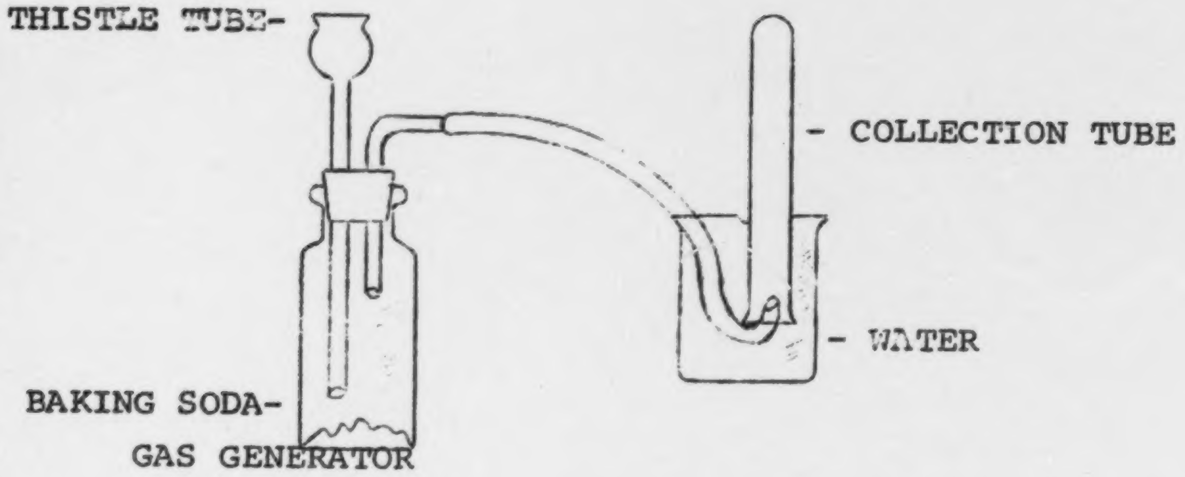
Material for groups of three:

1. Gas bottle
2. Thistle tube
3. Rubber Tubing
4. Baking soda
5. Vinegar
6. 4 Solid Stoppers #3
7. Beaker
8. 4 test tubes
9. Bromthymol blue
10. Box kitchen matches
11. Rubber stopper # 6½
12. "L" Shaped Glass Tube

Two of the most important gases to man are carbon dioxide and oxygen. In this activity, we will make some carbon dioxide. Carbon dioxide is found in the lower levels of the atmosphere. It is produced when anything containing carbon burns, and when plants or animals are using energy.

Assemble the equipment as it is shown in the diagram. Remove the stopper and add about two spoonfuls of baking soda to the gas bottle. Then, replace the stopper and add through the thistle tube enough vinegar to cover the baking soda. Place the end of the rubber tube up into the test tubes filled with water and bubble the gas into the tube until all the water is forced out. What forced the water out?____________________ Stopper the test tube.

Fill the second tube in the same manner.



Strike a match and place it into the first test tube #1. Does the match burn or is it put out? ____________________

Test the gas being produced by placing the end of the rubber tube into test tube number three containing about 2 ml of bromthymol solution and allowing the gas to bubble for a few minutes.

Place the tube near your nose. Does the gas have an odor? What about taste?

Now fill a third test tube with water, disconnect the rubber hose from the generator and force the water out of the test tube by blowing through the hose. Strike a match and place it into a second test tube. Does the match burn or is it put out?_______

____

Add 2 ml of bronthymol to a fourth test tube, using the rubber tube bubble your breath into the solution for 1 minute. What happened?_________________

Student B - 21
Page 3

Record what you see.

1. Does the match burn in carbon dioxide?
2. What effect does carbon dioxide have on Bromothymol?
3. What effect did the exhaled air have on the match. The Bromthymol blue?
4. What can you say about the gas in exhaled air and the carbon dioxide produced with vinegar and baking soda?

NOTE: You may also produce carbon dioxide by placing dry ice into water. "Dry Ice" is nothing more than frozen, SOLID carbon dioxide. Carbon dioxide freezes at about - 78°C, water freezes at 0°C.

TEACHER DIRECTION

B - 22

OXYGEN

Materials for groups of three:

1. Large Test Tube
2. Alcohol Burner
3. Test Tube Holder
4. 3 Test tubes
5. One hole stopper
6. Glass tube 3" long
7. 3 Rubber Stoppers Solid # 3
8. Beaker
9. Hydrogen Peroxide
10. Wood Splints
11. Bromthymol
12. Soda Straws

TODAY, WE WANT TO MAKE ONE OF THE MOST IMPORTANT GASES KNOWN TO MAN --- OXYGEN. WE ARE GOING TO TAKE THE OXYGEN OUT OF HYDROGEN PEROXIDE, WHICH HAS LOTS OF OXYGEN IN IT. WHAT OTHER USES DO WE HAVE FOR HYDROGEN PEROXIDE? (Some will suggest "peroxide blondes").

COULD YOU LIVE WITHOUT OXYGEN? WHERE DOES MOST OF IT WE BREATHE COME FROM? (The class may not know green plants are responsible for the major portion in the atmosphere).

CAN YOU SEE OXYGEN? CAN YOU TASTE IT? DO THEY ALLOW PEOPLE TO SMOKE IN AN OXYGEN TENT? (Pause) WHY NOT? IS THERE OXYGEN AT HIGH ALTITUDES IN THE EARTH'S ATMOSPHERE? WHY NOT? (heavier than air). You may also discuss oxygen masks in high-flying aircraft, torches, etc.)

LET'S MAKE THIS GAS AND THEN TEST IT.

Pass out B-22

STUDENT

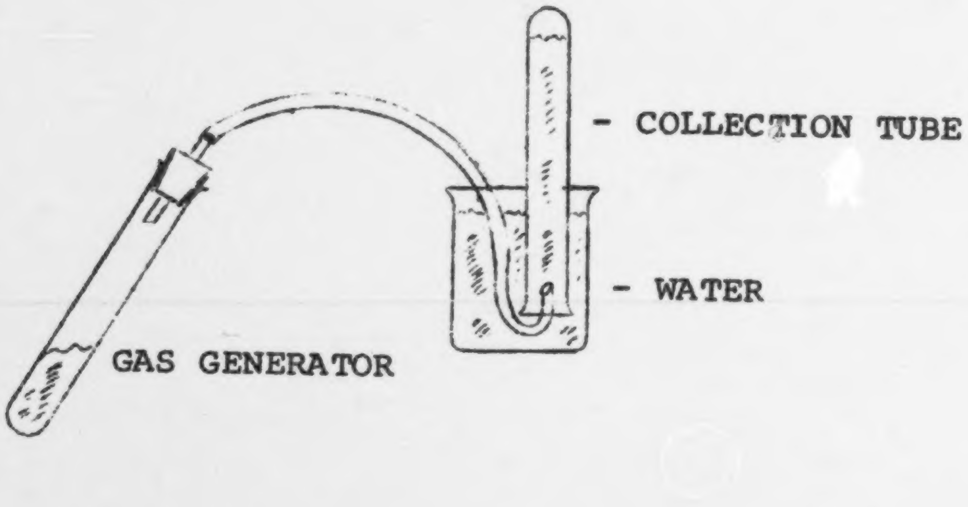
B - 22

OXYGEN

Materials for groups of three:

1. Large test tube
2. Alcohol burner
3. Test tube holder
4. 3 small test tubes
5. One hole stopper #3
6. Glass tube 3" long
7. 3 Rubber stoppers #3
8. 2 beakers
9. Hydrogen peroxide
10. Wood splints
11. Bromthymol
12. Soda Straws

In this activity, we will make oxygen, the gas necessary for all forms of animal life. This gas makes up about 20% of our atmosphere. Without this gas we would soon die. Later we shall see that this gas is given off by all green plants.



Place about ½ of a test tube of Hydrogen Peroxide into the big test tube. Then add the stopper as shown in the diagram. Fill and invert the test tube with water to collect the oxygen generated. Now place the end of the rubber tube into one of the three test tubes filled with water. Begin heating the Hydrogen Peroxide slowly. Continue heating until all of the water has bubbled out of the tube. Fill the remaining two tubes in the same manner. Put a rubber stopper into each tube and set it upright in an empty beaker, or test tube rack.

1. Place a glowing splint into the first tube. Was it extinguished? Did it burst into flame? Repeat with the second tube. What happened?________________________
2. Bubble some of the oxygen into another test tube with Bromthymol solution for (1 minute) What happened?__________
3. Bubble your breath into some bromthymol with a straw until the Bromthymol changes color. Then bubble the oxygen from the generator into the changed Bromthymol. Now record what you saw:
    1. What happened to the glowing splint?__________________
    2. Would this gas make a good fire extinguisher?__________ Why?
    3. What happened when oxygen was bubbled into the Bromthymol solution?______________________ Why?
    4. What happened to the Bromthymol solution with exhaled air in it when oxygen was bubbled into it? Why?________
    5. What differences can you think of between carbon dioxide and oxygen? ____________ ____________ ____________

TEACHER DIRECTION B - 23

CARBON DIOXIDE AND GREEN PLANTS

Materials for groups of three:

1. 4 test tubes
2. Bromthymol Blue
3. Elodea
4. Soda Straws
5. Wax pencil
6. Medicine Dropper
7. 4 Stoppers solid #3

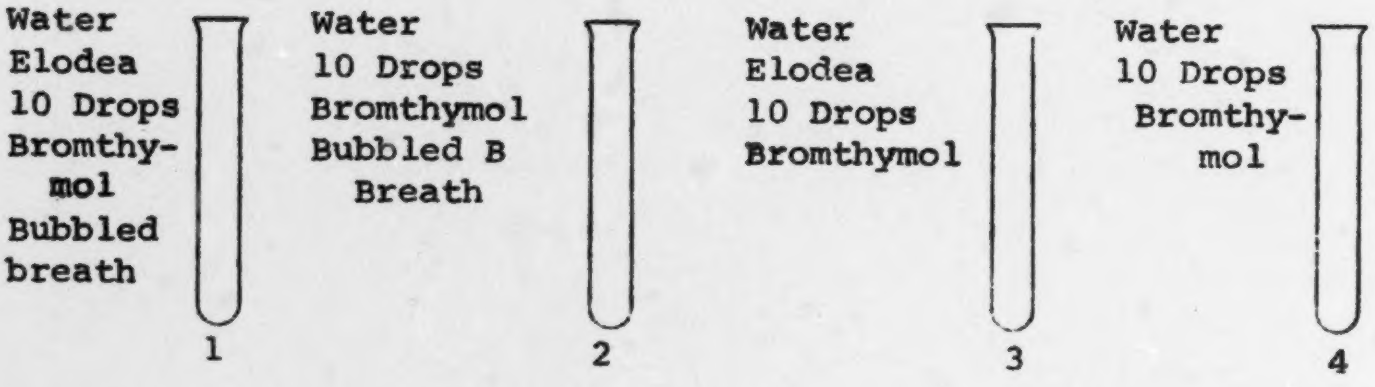
Again the success of the activity depends on an understanding of the reaction of Bromthymol blue, which serves as the indicator. Bromthymol blue is blue in basic solutions (absence of carbon dioxide) and yellow in acid solutions (carbon dioxide present). As students blow their breath into the solution this color change from blue to yellow should become apparent. Pass out B-23

TODAY WE ARE AGAIN GOING TO USE THE CHEMICAL BROMTHYMOL BLUE. WHAT COLOR IS THIS CHEMICAL IF YOU ADD CARBON DIOXIDE TO IT? (yellow) IN THIS ACTIVITY I WANT YOU TO SET UP FOUR TEST TUBES LIKE THIS. (use transparency B-23) INTO EACH TEST TUBE ADD ENOUGH WATER TO HALF FILL THE TUBE. THEN ADD ABOUT TEN DROPS OF BROMTHYMOL TO EACH TUBE. NOW FOLLOW THE INSTRUCTIONS OF YOUR LABORATORY SHEETS

This activity will be continued overnight and provision should be made for a light source overnight.

TEACHER DIRECTION
Page 2

Use the transparency B-23 and draw in on the overhead what goes into each tube leaving the transparency on the screen during the activity.


Water
Elodea
10 Drops
Bromthy-
mol
Bubbled
breath
1
Water
10 Drops
Bromthymol
Bubbled B
Breath
2
Water
Elodea
10 Drops
Bromthymol
3
Water
10 Drops
Bromthy-
mol
4

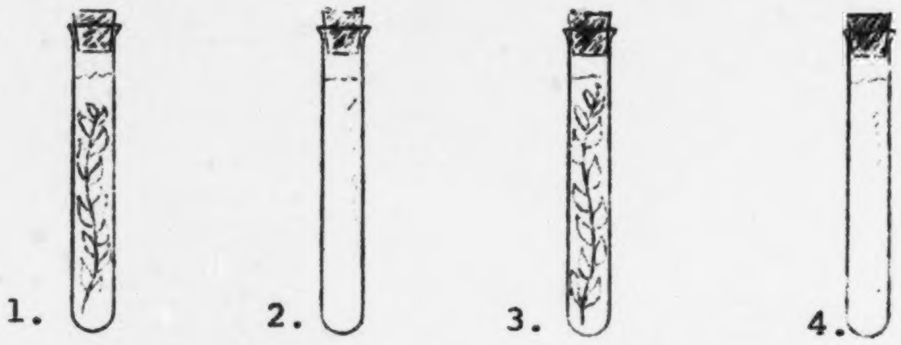
STUDENT B - 23

CARBON DIOXIDE AND GREEN PLANTS

Materials for groups of three:

1. 4 test tubes
2. Bromthymol
3. Elodea
4. Soda straws
5. Wax pencil
6. Eye droppers
7. 4 Rubber stoppers solid #3

As you learned in your work with the burning candle, bromthymol blue changes to yellow in the presence of CO_2. You can now use this indicator to determine if $CO_2$is present around water in a growing green plant.



Number four test tubes 1 through 4. Fill as shown each test tube with water. Put enough drops (about ten) of bromthymol blue solution into each test tube so that a light blue color is present. Bubble your breath through a soda straw into tubes 1 and 2 until there is a color change. Put an Elodea sprig in tubes 1 and 3. After you have completed this set up, (see illustration) stopper each of the four tubes and place in a beaker in a bright light.

If carbon dioxide is released by the elodea in bright light, then the liquid in tube 1 should change to a ________________ color.

Why did we have tube number 2?________________________

Why did we have tube number 4?________________________

Did the plant use or release carbon dioxide?____________

Now, record what you see and account for what you see.

1. What color is each of the tubes at the beginning?
2. Why did bubbling your breath into tubes 1 and 2 change the color?
3. Why do we leave the tubes in bright light?
4. What do you suppose would happen if the tubes were left in total darkness?
5. Leave the tubes in bright light overnight and note the difference.
6. What color changes are there in tubes 1 and 3?
7. Why did this change take place?
8. Why did we have tube number 4?
9. What can we prove with this tube?

TEACHER DIRECTION B - 24

OXYGEN AND GREEN PLANTS

Materials for groups of three:

1. 1 large gallon jar
2. 1 glass funnel
3. 1 sprig of Elodea or mass of algae
4. Coins
5. Test tube
6. Splints
7. Soda straws

The small aquarium plant Elodea may be purchased from a pet shop or any store selling aquarium supplies. A large mass of algae may be used also. Make sure students understand the purpose of the set-up, and that any gases given off will be collected in the test tube by water displacement. Three coins should be placed under the edge of the funnel to allow circulation of the water around the plant.

Pass out B-24

WE KNOW PLANTS TAKE IN CARBON DIOXIDE (relate to B-23) BUT WHAT DO THEY GIVE OFF? (Place the transparency on the overhead) and explain the purpose of each part of the set-up. NOW SET UP YOUR EQUIPMENT LIKE THE DRAWINGS (leave the transparency on the screen.)

CAUTION: Do not use copper pennies since these will kill the plant if it touches the copper.

The plants should be left overnight with a light source.

STUDENT B - 24

OXYGEN AND GREEN PLANTS

Materials for groups of three:

1. Large gallon jar
2. Funnel
3. Sprig of Elodea or mass of algae
4. Test tube
5. Splints
6. Coins
7. Soda Straw

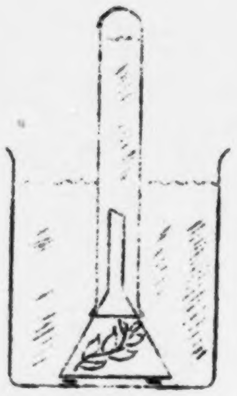
Most of us know that chlorophyll, the green pigment in plants, is a very important chemical. But, did you know that this green material is the agent that captures the energy found in all the food we eat? Also, in this process the gas oxygen is produced.

In this activity, we shall see a gas given off by a plant and later test to see if the gas we have collected is oxygen. Plants that live in water give off gases just as land plants do. This gas can be seen leaving the plant through the water in the form of tiny bubbles.

Add water to the gallon jar until it is 2/3 full. Then bubble carbon dioxide into the water for 3 or 4 minutes using a soda straw. Add a healthy sprig of Elodea to the water and cover with the funnel. (See illustration) Place a test tube filled with water over the spout of the funnel. Be careful not to allow air to enter the tube.

Student B-24
Page 2

The jar should be placed in direct sunlight or near a bright light. Keep the plant in light all night. Place it in sunlight again in the morning. At the next class period, observe what has happened.



Now let's record and account for what we see.

1. What has happened in the test tube?____________________
2. What do you see on some of the plant leaves?_________
3. Where did the gas in the test tube come from?________
4. Shake the funnel and note where the tiny bubbles go?
   ____
5. Why does the water around the plant need to circulate?
   ____

Now let's find out if the gas we have captured is really oxygen. What is the test for CO_2? O_2? You already know the test for carbon dioxide and oxygen. Carefully remove the test tube by placing your finger over the mouth of the test tube then place a glowing splint into the tube.

1. What happens to the glowing splint?

Student B-24
Page 3

2. What gas do you suppose was in the tube?
3. What would happen if we repeat this investigation leaving the plant in total darkness?
4. Would you like to try this?
5. How could we do this?

TEACHER DIRECTION B - 25

DIFFUSION

Materials for groups of three:

1. Cellophane tubing
2. Soluble starch solution
3. String
4. Glucose solution
5. Beakers
6. Graduate cylinder
7. Benedict's Solution
8. Iodine solution
9. Alcohol burner
10. Droppers
11. Test tubes

Dialysis tubing is the best type of cellophane tubing for this activity. Cut it into 5 inch strips. The dialysis tubing should be soaked in water for a few minutes before students work with it. Liquid starch is soluble starch and clear Karo syrup is a good source of glucose. You will have to dilute the glucose about 10 to 1.

If poor results are obtained after 15-20 minutes, replace the tubing in the beaker and leave it overnight and then repeat the test.

Relate the cellophane bag to a living cell membrane since both are semipermeable membranes.

Explain that chemical tests can be used to determine the presence of glucose and starch.

Take some of the starch solution and add two drops of iodine to it. WHAT COLOR IS THE STARCH SOLUTION NOW? ANYTIME STARCH AND IODINE ARE MIXED, YOU WILL GET THIS SAME COLOR CHANGE. NOW LET'S TEST FOR SUGAR. WE WILL USE BENEDICT'S SOLUTION. NOTICE ITS COLOR. NOW WE MUST HEAT THE SOLUTION. (place the tube into boiling water for 2-3 minutes) WHAT COLOR IS THIS? WHAT COLOR CHANGE DO YOU GET WHEN YOU HEAT SUGAR AND BENEDICT'S SOLUTION?

Teacher Direction
page 2

If an alcohol burner is used to heat the test tube students should be cautioned about pointing the test tube away from other students. A beaker of boiling water will also produce the color change, by placing the test tube and its contents in the boiling water.

STUDENT B - 25

DIFFUSION

Materials for groups of three:

1. Cellophane tubing
2. Soluble starch solution
3. String
4. Glucose (White Karo Syrup)
5. Beakers
6. Graduate cylinder
7. Benedict's solution
8. Iodine solution
9. Alcohol burner
10. Test tube holder
11. Wax pencil

Since all of the chemical reactions in living things go on inside the cell, food must be able to get into the cell. Some foods are too large to get into the cell, while others are small enough to enter. Let's see if we can find foods that can pass through a cell's membrane.

1. Tie a string very tightly around one end of a piece of cellophane tubing. Fill the tubing about half full with liquid starch solution. 2. Now add 40 drops of glucose (sugar) solution to the same cellophane tubing. 3. Tie the top of the cellophane tubing with another piece of string. Hold the tubing under running water for a few seconds to wash off any material on the outside of the tubing. Now place the tubing in a beaker of water. 4. Now measure 5 ml of water into a test tube and mark the top of the water level with a wax pencil. Then, empty the water. Add 5 ml of Benedict's solution to the marked tube and heat on the alcohol burner or beaker of boiling water. Does any change occur?___________ After the filled tubing has soaked 15 or 20 minutes, pour 5 ml of the water from the beaker into a test tube. Then pour 5 ml into another test tube. Mark the

test tubes 1 and 2.

We will now test the water in test tube 1 for starch. Add one or two drops of iodine to the water. Does the water change colors? __________ What color is it? __________ If it turns black or purple, then there is starch in the water. Is there any indication of starch in your test tube? __________ Should there be any starch in the test tube? __________ Can st[illegible] pass through a membrane? __________

Now let's test the water in test tube 2 for sugar. Add about 20 drops of Benedict's solution to the test tube. Heat on the burner for 2-3 minutes.

What color was the water in the test tube before you heated it? __________ Was there any change in color while you heated it? __________ What was the color change after heating? __________ If the solution turns yellow or orange, it shows that glucose (sugar) is present. Is there any glucose in your test tube? __________ Can glucose (sugar) pass through the tubing? __________ How do you know? __________ Glucose is a basic food used by the cell to produce energy.

We say that when a membrane allows some materials to pass through and stops others, the membrane is semi-permeable. Is the cellophane tubing semi-permeable? __________ If the membranes around cells are semi-permeable, which foods would go through? __________ Why do cell membranes have to be semi-permeable? __________________________

TEACHER RESOURCE

In this series of activities we will demonstrate to students some of the materials present in leaves that are responsible for the colors we see. The green is a result of the Chlorophyll, and it plays a major role in the production of food in a process known as Photosynthesis. However, there are other materials present which usually can be seen in the fall of the year. The bright yellows are due to the Carotenes and the reds from the Anthocyanins. Each of these materials may be removed by using the proper solvent. In the removal of Chlorophyll alcohol will be used. The red pigment or the Anthocyanins are soluble in boiling water. The removal of the Carotenes (yellow) will require the use of acetone which is flammable, students should be cautioned about its use.

Any leaf may be used for the removal of Chlorophyll, however for maximum results with red, and yellow; leaves with large amounts of these pigments should be chosen such as: Coleus, Crotons, etc. In the fall or winter a large number of wild, red and yellow leaves will be available.

The red pigments when removed may be used as acid base indicators. These colors may be varied from purple (basic) to red (acid). This extract may also be removed in large quantities from red cabbage.

It should be stressed that these various color pigments are masked by the large amounts of Chlorophyll during the summer, but with the decrease of photosynthetic activity in the fall and winter these colors appear. After each pigment is removed students should test it with the Chromatography technique used in B-27

STUDENT

B - 26

EXPERIMENTS WITH GREEN PLANTS

When animals get hungry, they search for food. In searching for food they move about. Some of them fly, some crawl, some swim, some hop and some walk or run. Unless an animal is able to find food it cannot continue to live.

Most plants cannot move about to search for food. They cannot fly, crawl, swim, hop, walk, or run. Their roots hold them firmly in the soil. Yet they are able to keep growing and seem to have plenty of food.

For a long time people believed that plants used only soil for food. A few thoughtful people noticed that plants which grew in pots did not seem to use up the soil. No matter how large such plants became, the amount of soil in the pots remained about the same. This was very puzzling.

At last a man thought of an experiment to find out whether plants use soil for food. He placed a pot of soil in the oven. He heated it until all the water was driven off and the soil was very dry. Then he weighed the pot of soil very carefully and wrote down its exact weight. Next he planted some seeds in the soil, and gave them plenty of water. When the seeds had grown into large plants, he removed these plants, roots and all, from the pot. He dried the pot of soil again and weighed it. It weighed only a little less than it had before. The plants had gained a great deal in weight, but the soil had lost only slightly in weight.

Student
page 2

Many other experiments have been carried on to solve the puzzle of how plants get food. Some of these experiments are easy to do. They help us understand how plants live and grow.

When a potted plant does not get enough water, the leaves become wilted. Turning such a plant upside down and placing its leaves in water will not help at all. But if some water is poured on the soil near the roots, the leaves become fresh and full again. This experiment shows that leaves do not take in water, but that roots do.

Today the experiments with green plants are even more surprising. Scientists have experimented with plants by growing them under different colored lights to find the best color for growth. Scientists have also studied how different amounts of light effect plants. Some have even experimented with the effects of growing plants to different kinds of music.

Through experiments some scientists have reached the conclusion that plants may be able to feel pain. Perhaps some of these experiments will give you some ideas for experiments you can perform with plants. Remember keep off the grass it may feel pain!

TEACHER DIRECTION B - 27

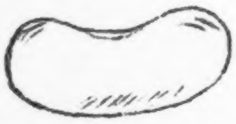
EFFECTS OF SUNLIGHT ON PLANTS

Materials for groups of three:

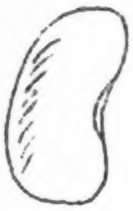
1. 2 small milk cartons
2. 4 Pinto beans
3. Small amount of soil

WILL A SEED GROW IN THE DARK? Discussion. DOES THE SEED NEED FOOD? Discussion. WHERE DOES THIS FOOD COME FROM? Discussion. IF THE SEED DOES GROW IN THE DARK WHAT COLOR WILL THE PLANT BE? Discussion. WILL IT BE THE SAME COLOR IF IT IS GROWN IN SUNLIGHT? Discussion. Pass out B-27 and enough seeds for each group. Read over the activity with the class and answer any questions.

NOW, IN WHICH DIRECTION WILL WE PLANT THE SEED:



1.



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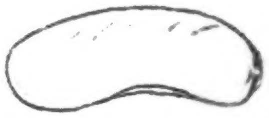


3.

WILL IT MAKE ANY DIFFERENCE? LET'S TRY THIS, TOO. ALSO, WE WILL LEAVE ONE CARTON OF SEEDS IN THE DARK AND ONE CARTON IN THE LIGHT. NOW LET'S GET STARTED.

STUDENT

B-- 27

EFFECTS OF SUNLIGHT ON PLANTS

Materials for groups of three:

1. 2 small milk cartons
2. 4 pinto beans
3. Small amount of soil
4. Scissors, razor blade

Sunlight furnishes vast quantities of energy for both plants and animals. However, all plants do not get or need direct sunlight. Since most of the plants we know about grow from from seeds, let's take some seeds and grow some plants. Will the seeds produce plants if they are left in the dark? If they do grow, will they produce plants like the seeds grown in sunlight.

Take two small milk cartons, cut the tops off, and fill them with soil. Now place two seeds in the corners of each carton about ¼ of an inch below the surface of the soil. Will it make any difference if the seeds are planted upside down or right side up? Try this.

Add just enough water to moisten the soil. Too much water will cause the seeds to rot. The soil should be checked daily and enough water added to keep the soil damp. Place one carton in light and the other in total darkness. Observe each school day for a period of two weeks. Record what you see in the table below:

	LIGHT	DARKNESS
1. How long before you notice any signs of growth?	____________	____________
2. What was the first part of the plant to appear above the ground?	____________	____________

Student
page 2

	LIGHT	DARKNESS
3. How high was the plant after (5) days?		
4. How long was it before leaves appeared?		
5. Did the direction the seed was planted have any effect?		
6. According to seed direction which seed sprouted first?		

Record any differences you noted between the plants grown in the dark and those grown in the light.

TEACHER DIRECTION B - 28

COLOR SEPARATION

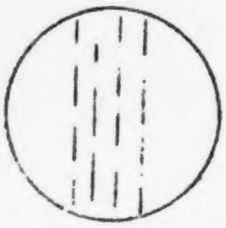
Materials for groups of three:

1. Three test tubes
2. Scissors
3. Cork
4. Paper clip
5. Filter paper
6. 3 colored ball point pens or three bottles of different colored ink.

As we enter the subject of leaf color we will attempt some activities with chromatography. To introduce the idea we will practice with colored ink.

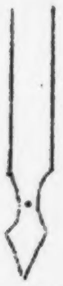
TODAY WE ARE GOING TO DO SOME REAL SCIENTIFIC WORK. IT IS CALLED CHROMATOGRAPHY HERE'S HOW YOU DO IT.

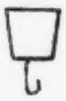
Have students cut out one strip of filter paper for each color of ink they will work with.

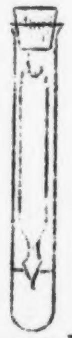


EACH STRIP SHOULD BE 3/4 OF AN INCH WIDE

The strips then should be shaped as shown in the diagram.







Bend and break the paper clip as shown and push the straight end into the cork. Attach the paper strip to the curved end after the ink has been added. If bottle ink is used, a tooth pick may be used to make a dot. This dot should be saturated with the ink and the tip placed in the solvent to the depth shown.

Teacher Direction
page 2

Students then should compare the strips made with the different inks, and note the spread of the different colors. The spread of colors should be along the spectrum.

Red - Orange - Yellow - Green - Blue = Indigo - Violet.

Each of the colors represents a different substance and each substance travels up the paper at a different rate. After the separation of color has occured the strips should be allowed to dry and then the comparison made.

We will use chromatography to separate each of the pigments we remove from leaves in later activities.

STUDENT

B - 28

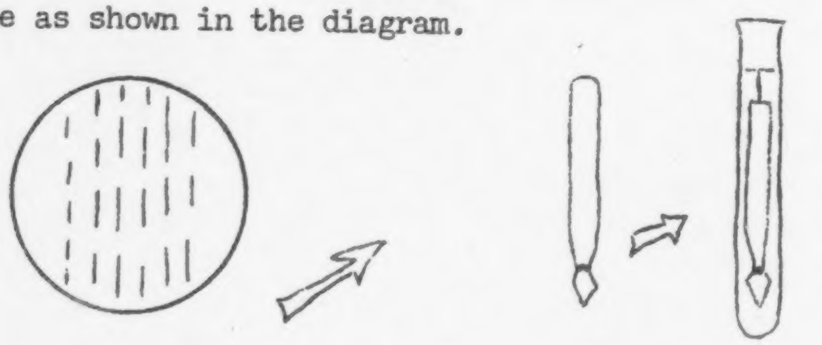
COLOR SEPARATION

Materials for groups of three:

1. Three test tubes
2. Scissors
3. Cork
4. Paper clip
5. Filter paper
6. 3 colored ball point pens or three bottles of different colored ink.

Scientists sometimes have unusual ways of finding answers. Today we will use one of these methods called chromatography. This method will show the make up of different materials. Be very careful as you do this activity because we will repeat this same activity later using different materials.

1. Cut the filter paper into strips 3/4 of an inch wide and then shape as shown in the diagram.



2. Place 5 ml of alcohol into the test tube.
3. With the colored ink make a dark dot at the point shown in the diagram.
4. Hang the strip from the paper clip and place into the test tube at the depth shown in the diagram.

Student
page 2

5. Watch closely as the liquid moves up the strip. Remove the strip when the liquid reaches the top. Notice that the different colors move at different speeds. Each of these colors represents a different substance.

1. How many different colors could you see after the strip dried? ____________________

2. What colors are present in red ink? ____________________

3. What colors are present in blue ink? ____________________

4. What colors are present in black ink? ____________________

5. Is there any order in the way the colors are arranged? ________

6. Compare your order to the spectrum.

Red - Orange - Yellow - Green - Blue - Indigo - Violet.

TEACHER DIRECTION B-29

CHLOROPHYLL REMOVAL

Materials for groups of three:

1. Funnel
2. Filter paper
3. Test tube
4. Alcohol
5. Mortar and Pestle
6. (package) Frozen Spinach

Pass out B-29. Read over the activity with the class. Answer any question that may develop. You will need to explain what the words SOLUBLE and INSOLUBLE mean. The chlorophyll is soluble in alcohol but not in water. To determine if the class knows the meaning of these terms, ask the class to name a few examples of solubility:

IS OIL SOLUBLE IN WATER?

IS GASOLENE SOLUBLE IN WATER?

IS ALCOHOL SOLUBLE IN WATER?

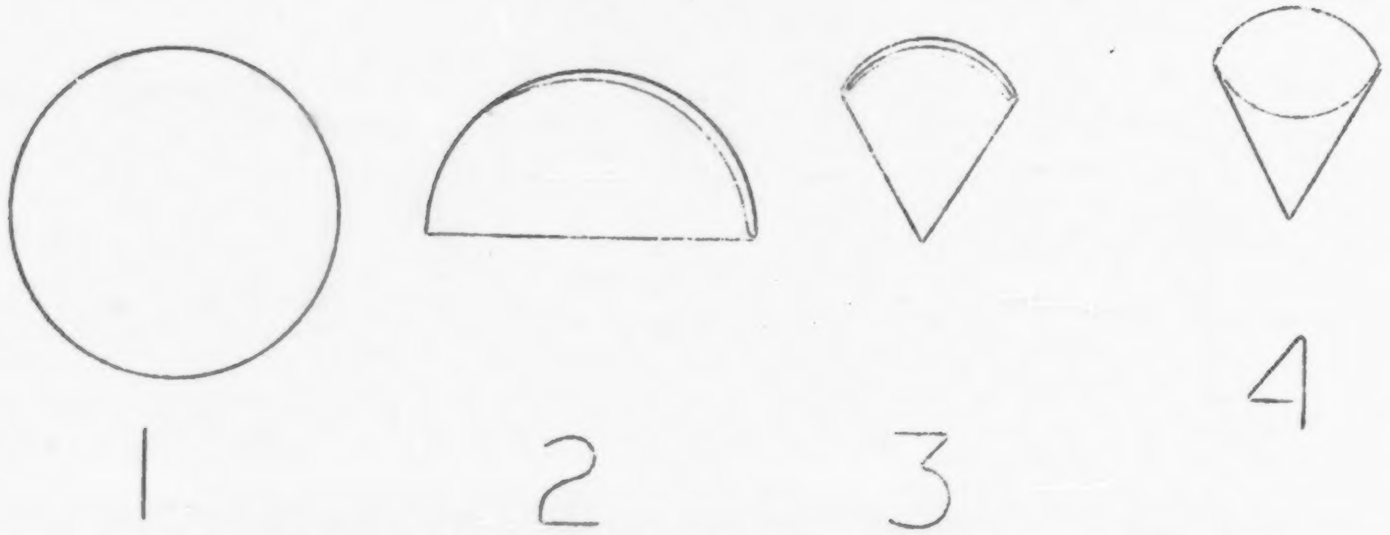
IS SUGAR SOLUBLE IN WATER?

CAN YOU NAME ANY OTHERS?

All of these examples should be demonstrated to the class

You may add others if necessary. These questions may require an additional set of activities to determine the solubilities of those suggested. After the activity you may demonstrate that chlorophyll is soluble in alcohol and insoluble in water.

FOLD FOR FILTER PAPER



Some students may not know that some plants do not have chlorophyll (mushrooms, etc.) These plants cannot make their food but must get food from other sources.

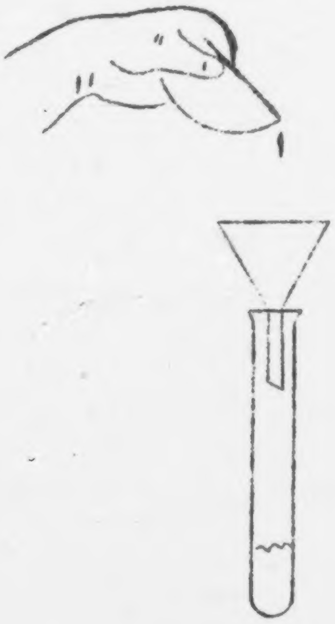
STUDENT B - 29

CHLOROPHYLL REMOVAL

Materials for groups of three:

1. Funnel	4. Alcohol
2. Filter paper	5. Mortar and Pestle
3. 2 test tubes	6. One package of frozen spinach

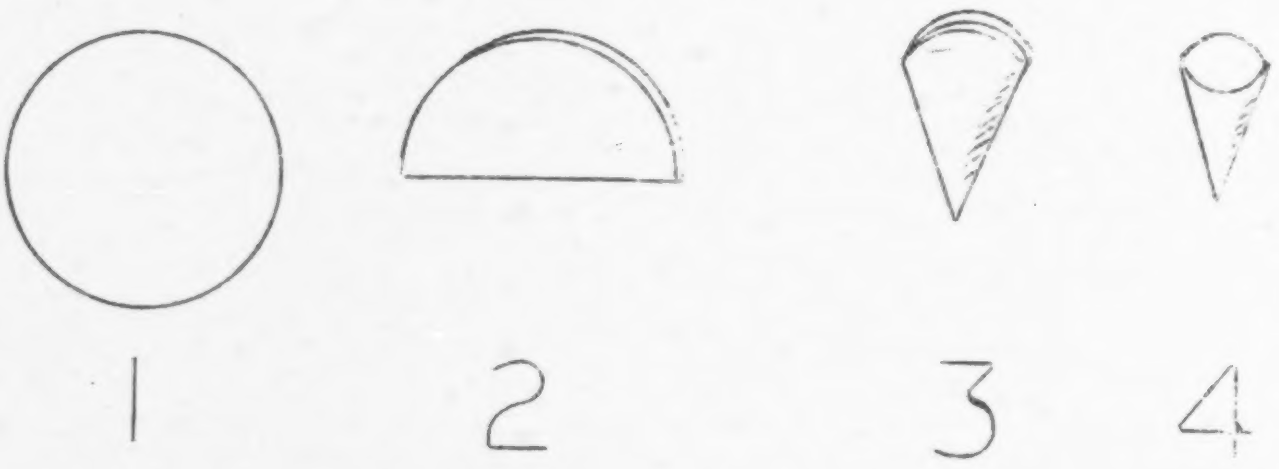
In an earlier laboratory we discussed the magical green chemical that we call chlorophyll. In this laboratory activity we are going to remove this green material from spinach. Take a small amount of the spinach that has been prepared place it in the mortar with the pestle and begin grinding. This will break down the cell walls and squeeze out the chlorophyll found inside the cells. You may need to add a small amount of water to the mixture as you grind it. After you have ground the mixture for two or three minutes you should then add enough alcohol to completely cover the spinach.



Student
page 2

As you add the alcohol to the spinach the liquid should begin to turn a slight green color, depending on how much chlorophyll you have released. If the liquid does not turn dark green continue to grind the spinach with the alcohol in the mortar and pestle.

After you have collected a liquid that is dark green in color this should then be filtered. Fold a piece of filter paper two ways, (see diagram) moisten it, and place it in a funnel as shown in the diagram.



You may need to stir the mixture in order to remove some of the large particles that may clog the funnel. Be careful not to tear the filter paper. The liquid should then be poured into the test tube. Pour 5 ml of the chlorophyll into another test tube for the test at the end of the activity.

Now let's record what we see. Why do you suppose we used the alcohol? ____________ What color is chlorophyll?____________

Student
page 3

Why could you not remove the chlorophyll by using only water?_____ _________ What color would the spinach be if you removed all of the chlorophyll from the leaves?____________ Could a plant live without this green material? ___________ Could photosynthesis be carried on in this test tube with the chlorophyll?___________ Even if we had light present?_______________

After you have removed the chlorophyll from the spinach, take the test tube with the chlorophyll in it and place it in front of a bright light. For your bright light source perhaps you can use the strong light coming from a slide projector or a movie projector. Hold the test tube of chlorophyll in front of the light and allow the light to pass through the chlorophyll. The test tube should be held about six inches from the light source.

Again let's record what you see. What color is the chlorophyll before you place it in front of the light?________. What happens to the chlorophyll when the bright light strikes it?__________. Does this same change take place in the chlorophyll where the light is not striking?__________ What happens to the chlorophyll when you remove it from the bright light?__________________

NOW REPEAT ACTIVITY B-28 USING THE 5 ML SAMPLE OF CHLOROPHYLL IN PLACE OF THE INK. WHAT COLORS ARE FOUND IN CHLOROPHYLL?__________ SAVE THE TEST STRIP FOR FUTURE USE.

TEACHER DIRECTION B - 30

RED PIGMENT REMOVAL

Materials for groups of three:

1. Funnel
2. Filter paper
3. Test tube
4. Mortar and Pestle
5. 250 ml Beaker
6. Alcohol Burner
7. Dilute Hydrochloric Acid
8. Ammonia
9. Leaves, turning red, or red Coleus

Pass out B-30 and read over it with the class. It may be necessary to again stress the words SOLUBLE and INSOLUBLE. Explain the reason for using Hydrochloric Acid (Hcl) in this activity instead of alcohol.

Again use the technique from B-28 to separate the pigment.

STUDENT

B - 30

RED PIGMENT REMOVAL FROM LEAVES

Materials for groups of three:

1. Funnel
2. Filter paper
3. 3 test tubes
4. Mortar and Pestle
5. Beaker (250 ml)
6. Alcohol burner
7. Dilute Hydrochloric Acid
8. Ammonia
9. Leaves that are beginning to turn red, or red coleus leaves or red cabbage

In this activity, we shall remove the materials that produce the bright red colors in a leaf, colors that are so familiar to us in the fall of the year. These red colors are produced in much the same way the yellow color is produced. They are present all year, but we do not see them because they are covered by the green chlorophyll.

These red pigments (anthocyanins) are present in great abundance in some leaves, such as variegated coleus, red cabbage and the croton. In the fall of the year as the amount of chlorophyll decreases these colors appear. These red pigments are soluble in boiling water.

Place a few leaves into the mortar and begin grinding with the pestle. After you have ground the leaves a minute or so to pulverize them, add water. Then, pour the mixture into a beaker and boil to remove the red pigment. The mixture should then be filtered through a funnel into a test tube. Once again you may need to stir the solution in order to stir up the larger particles that tend to clog the funnel and prevent the mixture from passing through the filter paper. Once you have filtered the solution, it should be clear but bright red in color, check the color in a bright light. Save 5 ml of the red pigment in a test tube for the test at the end of the activity. Divide the remaining solution into two equal parts, if the pigment is purple, then add a few drops of hydrochloric acid and note that the pigment becomes a bright red. Check its color in the light again. It changes as it becomes slightly acid. In test tube #2 add a few drops of ammonia and check the solution in the light. Then add a few drops of ammonia to test tube #1, check it in the light again. This is the same red pigment that produces the red color in the leaves we see in the fall.

Now repeat activity B-28 using the 5 ml sample of red pigment in place of the ink. Save the test strip for future use.

Now let's record what we see.

1. Where in the leaves do you suppose the red material is found?
2. Could it be red chlorophyll? _______________ Why?
3. What happens to #1 __________ and #2 ___________ when placed in front of a bright light?
4. Is this red material present in all green leaves during the summer months?
5. Have you seen it in young leaves during the spring?
6. Can you think of some plant that would be rich in this red material?
7. How does acid affect the color of these red pigments?
8. How does ammonia affect these red pigments?
9. Could this material be used for a dye?
10. How many different colors are in the red pigment?

TEACHER DIRECTION B - 31

YELLOW PIGMENT REMOVAL

Materials **for** groups of three:

1. Funnel
2. Filter paper
3. Test tube
4. Alcohol
5. Mortar and Pestle
6. Leaves that are turning yellow
7. Acetone

The activities dealing with the extraction of leaf pigments provide an excellent opportunity to discuss the subject of solubility. Students must again be cautioned as to the danger of such solvents as acetone and alcohol which are very flammable. Solubility is the basis for the dry-cleaning process as well as spot removers. Again you should try to relate the class discussion to things the students are familiar with outside of class.

Again students will repeat Activity B-28 using the yellow extract in place of colored ink.

STUDENT B - 31

YELLOW PIGMENT REMOVAL

Materials for groups of three:

1. Funnel
2. Filter paper
3. Test tube
4. Alcohol
5. Mortar and Pestle
6. Leaves that are turning yellow
7. Acetone

We have removed the green pigment that we call chlorophyll from leaves. In the fall of the year as the amount of chlorophyll decreases this reduction allows the other colors, red, yellow, orange, to show up.

Today we shall remove the material that causes the yellow color in leaves. The name of this material is carotene. Can you think of any vegetables that probably have a lot of this material in them?_______________________________ This material is different from chlorophyll in that it cannot be removed with alcohol. In place of alcohol for this laboratory experiment, we shall use another liquid called acetone. The odor of this material should be familiar to most girls in the class, since acetone is a major ingredient of fingernail polish remover.

We will remove the yellow pigment in much the same manner that we removed the chlorophyll, substituting acetone in place of the alcohol. Place one or two of the leaves into the mortar and cover them with acetone. You should begin grinding, and as you grind, you will notice a change in color of the acetone. (Acetone is a very flammable liquid, and will burn readily. Therefore, this experiment should not be performed around an open flame.) As you grind, the acetone should take on a yellowish-green color. After you have ground the leaves pour the liquid through the filter as before. You may need to stir the materials in the filter paper to unclog the funnel so that the liquid will pass through the filter paper easily. After you have collected the liquid, it should appear clear and sort of yellowish-green in color. Hold the liquid in bright light. What happens?__________________________

Now repeat activity B-28 using the yellow pigment in place of the colored ink. Save the test strip for future use.

Now let's record what we see:

1. Why could we not use water to remove the carotene?
2. Where in the leaf is this yellow material found?
3. Why do you not see this yellow color during the summer months?
4. What happens to the carotene when it is placed in front of a bright light?
5. Do you suppose the carotene functions during photosynthesis?
6. How many colors did you find in the yellow?

TEACHER DIRECTION B - 32

PRODUCTS OF BURNING

Materials for groups of three:

1 Starch	4. Tongs
2. Sugar cube	5. Teaspoons
3. Combustion dish	6. Alcohol burner

Pass out student directions and read with students.

Regular cubed table sugar and corn starch are satisfactory for this laboratory test.

If you wish you may have them test the gas that comes off for carbon dioxide.

Relate this exercise to the prior activity on burning a candle. Explain that these foods are the main sources of energy for living things and that similar combustions occur in cells.

Discuss the results of the lab with students.

NOTE: You will need to add a few cigarette ashes on top of the sugar cube. The ashes serve as a catalyst and without this catalyst the students probably will not be able to get the sugar cube to burn.

STUDENT B - 32

PRODUCTS OF BURNING

Materials:

1. Starch
2. Sugar cube
3. Combustion dish
4. Tongs
5. Spoon
6. Alcohol burner

Fuel foods are essential to life and health. They are an important part of the daily diet since they burn in the body to supply energy.

Put a cube of sugar into a combustion dish. Sprinkle some of the ashes, prepared by your instructor, onto the cube then ignite it with a match. The ashes serve as a catalyst for this reaction. Is sugar a fuel?______________ Is the burning of sugar similar to the burning candle?_______________ Do you see any smoke coming off?_________________ What gas do you think is in the smoke? ____________________ How could you prove what gas was in the smoke?

Now take a half-teaspoon of starch, add some ashes and place the mixture into a combustion dish and heat it until it begins to burn. Which seems to burn better, the sugar or the starch?_____________ Is there any heat given off by the starch?_____________. Is there any gas given off by the starch?____________

TEACHER DIRECTION B - 33

LUNG CAPACITY

Materials for groups of three:

1. Gallon jar
2. Rubber tubing with mouthpiece
3. 100 ml. graduated cylinder
4. Wax pencil
5. Pan

IN ORDER FOR FOODS TO BE USED INSIDE THE BODY THERE MUST BE LARGE AMOUNTS OF OXYGEN AVAILABLE AND SOME MEANS OF GETTING RID OF THE WASTE GAS CARBON DIOXIDE. HOW MUCH AIR DO YOU THINK IT TAKES TO FILL THE LUNGS? (Discussion) OF THIS AMOUNT HOW MUCH IS OXYGEN? (20%) HOW DO YOU SUPPOSE WE COULD FIND OUT HOW MUCH AIR IT TAKES TO FILL THE LUNGS? (Discussion) DO YOU THINK IT WILL TAKE MORE OR LESS AIR TO FILL THE LUNGS OF A SMOKER THAN A NON-SMOKER.

Pass out B-33

Students should measure the volume of the gallon jug in ml using a 100 ml graduated cyliner. Using a felt pen make a mark on the side of the jug for each 100 ml. Empty gallon milk jugs may be used or empty jugs from snow cone sales if available.

Ask students to bring these in. This will get them involved in the preparation for the activity.

STUDENT B - 33

LUNG CAPACITY

Materials for groups of three:

1. Gallon jug
2. 100 ml graduated cylinder
3. Pan
4. Rubber tubing with mouthpiece
5. Wax pencil

The human lung is the organ where inhaled oxygen is excanged for the waste gas, carbon dioxide. In order for you to get all the oxygen you can, your lungs contain many air sacs. Gases are exchanged between the air in the air sacs and the blood. This is a slow process but there are so many air sacs that plenty of oxygen is provided to the body.

To find out how much air it takes to fill your lungs, fill a gallon jug with water, 100 ml at a time. Mark the water level after each 100 ml is added.

Turn the jug upside down in a large pan of water. Blow through a rubber tube into the jug upside down in a large pan of water. See how much water is forced out of the jug with a normal breath. (Use a clean mouthpiece.) Measure the volume of air exhaled during a normal breath. ________________ Measure the volume of air exhaled during a deep breath. ____________________

The greatest volume of air that you can exhale is called your lung capacity. Do you think you can force all the air completely out of your lungs?______________________

Why or why not?____

TEACHER DIRECTION B - 34

RESPIRATION IN MAN

Materials for groups of three:

1. 1-100 ml graduate cylinder
2. 2 or 3 gas bottles
3. Sodium hydroxide in a dropper bottle
4. 1% solution of phenolphthalein in dropper bottle
5. Soda straws
6. Dropping pipette

Pass out student directions and read the directions with students. Emphasize the relationship between exercise and carbon dioxide production. The more exercise, the more food burned, the more food burned the more carbon dioxide given off.

IN THIS ACTIVITY WE SHOULD SEE THAT MORE EXERCISE PRODUCES MORE CARBON DIOXIDE. THE AMOUNT OF CARBON DIOXIDE PRODUCED IS A WAY OF MEASURING HOW MUCH FUEL HAS BEEN BURNED IN THE CELLS.

The phenolphthalein powder should be dissolved in ethyl alcohol. Care should be taken to prevent mixing the sodium hydroxide with the phenolphthalein since this will cause the color reaction, if this occurs the clear color may be restored with the addition of dilute hydrochloric acid.

Explain that chemicals such as phenolphthalein and sodium hydroxide can be used as indicators for the presence of carbon dioxide gas. If phenolphthalein is clear, then CO_2 is present. Adding sodium hydroxide eliminates this CO_2. The amount of sodium hydroxide added indicates the amount of CO_2 that was present.

The first flask students prepare is the control flask. It should be labeled number 1 and put aside.

Teacher Direction
page 2

Put the acetate of the chart on the overhead projector and explain that they are to fill in their own chart with their results.

After the completion of the activity, discuss the results with the entire class.

STUDENT B - 34

RESPIRATION IN MAN

Materials for groups of three:

1. 1-100 ml graduate cylinder
2. 2 or 3 Gas bottles
3. Sodium Hydroxide in a dropper bottle
4. 1% solution of phenolphthalein in a dropper bottle
5. Soda straws
6. Dropping pipette (eye dropper)

7 Wax pencil.

We know that carbon dioxide gas is a result of the burning of fuels. If this is true, the more fuels that are burned, the more carbon dioxide that should be produced. When fuels are burned, energy is produced. We use this energy to move. The more we move, the more energy we need. Exercise then, would cause us to use more fuel and produce more carbon dioxide. The more we exercise, the more carbon dioxide we should exhale. Let us see if this is true.

Measure 100 ml of water and put it in to gas bottle. Add five drops of phenolphthalein to the water. Is there any change in the color of the water?_______________. If the water turns pink, this means that there is no carbon dioxide in the water. If the water is clear, there is some carbon dioxide present. To get rid of this carbon dioxide, add one or two drops of sodium hydroxide until the water is a slight pink color. Count how many drops of sodium hydroxide you added before the water turned pink and record this number on your chart. Put this bottle off to the side. Label it bottle number 1. It is to be used as your comparison.

Now measure another 100 ml of water and add it to the second bottle. Add 5 drops of phenolphthalein to this bottle. Have one member of the group sit quietly for 1 minute and then have him put one end of a soda straw in the second bottle and blow steadily through the straw for ten seconds. Add sodium hydroxide drop by drop until the pink color stays for 15 seconds (this pink must match the pink in bottle No. 1). Record the number of drops of sodium hydroxide used on your chart. Empty the bottle and wash it out. Add 100 ml of new water and 5 drops of phenolphthalein to the clean flask.

Exercise one minute by walking in place. Immediately, bubble air into the bottle of water for ten seconds. Then, add sodium hydroxide drop by drop until you get the same color pink as in bottle No. 1 again. Record the number of drops used on your chart.

Sodium hydroxide gets rid of carbon dioxide from the water and causes the phenolphthalein to turn pink in water. How much sodium hydroxide was needed to get rid of the carbon dioxide in your lungs when you were not exercising?____________________ Did the amount of sodium hydroxide needed increase as you exercised more?______________ Was the amount of carbon dioxide produced more when you rested or when you exercised?________________. What was

Student
page 3

the purpose of bottle No. 1? ____________ We call this a control. Is a control valuable in an experiment. Why?

It is true the more we exercise, the more carbon dioxide we release? If we release more carbon dioxide as we exercise more, then should we require more food? __________

	DROPS OF SODIUM HYDROXIDE	DROPS OF SODIUM HYDROXIDE NEEDED TO GET RID OF CO_2 FROM LUNGS
BEFORE BUBBLING		
AFTER RESTING		
AFTER MILD EXERCISE		
AFTER VIGOROUS EXERCISE		

TEACHER DIRECTION B - 35

CARBON DIOXIDE RELEASE BY PLANTS

Materials for groups of three:

1. 2 Fermentation tubes
2. Yeast suspension
4. Bromthymol blue indicator
5. 2 flasks

In this activity the sugar solution can be Karo light syrup diluted about 10 to 1 with water. To make the yeast suspension, mix one package of dry yeast with 200 ml of water. The two solutions should be mixed and ready before class. However students should be told what the solution contains and how they were prepared. Make sure that the two solutions prepared are not contaminated by mixing by the students. TUBE NUMBER ONE IS THE EXPERIMENTAL TUBE AND TUBE NUMBER TWO IS THE CONTROL. SHOULD ANYTHING HAPPEN IN TUBE NUMBER TWO?

The next day ask what caused the change in the level of the liquid in the tube. Using Bromthymol blue, they should test to see if the gas that has accumulated is carbon dioxide. Relate this to the burning experiment.

DID A TYPE OF BURNING OCCUR IN THE TEST TUBE WITH SUGAR AND YEAST? WHAT WAS THE FUEL? WHAT MUST HAVE BEEN THE STARTER OR CAUSE OF THE BURNING?

They should realize that in the tube without the yeast, no reaction or "burning" took place. This would indicate that the yeast was necessary for the reaction.

YEAST CELLS ARE LIVING CELLS WHICH CONTAIN A CHEMICAL CALLED AN ENZYME. AN ENZYME IS THE STARTER FOR CHEMICAL REACTIONS OCCURRING INSIDE LIVING CELLS.

Teacher Direction
page 2

This should bring up the question of how did the sugar get into the cells? HOW DO YOU SUPPOSE THE SUGAR GOT INTO THE YEAST CELLS.

Lead into a discussion of diffusion

STUDENT

B - 35

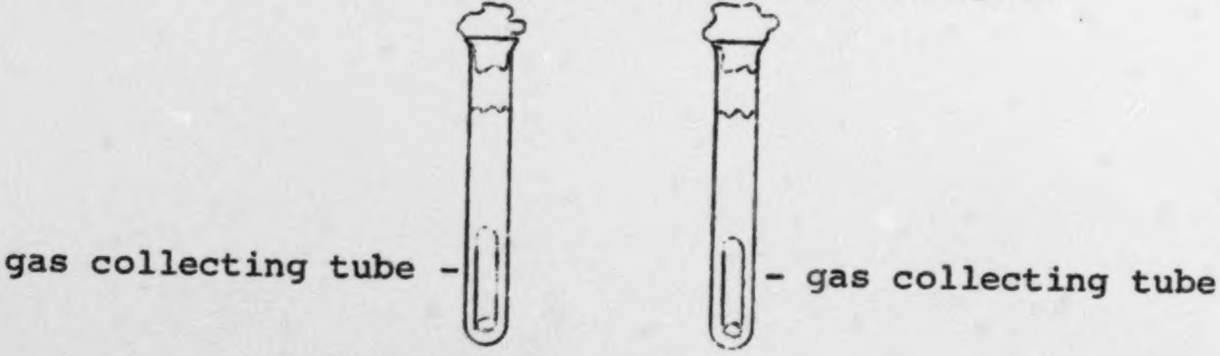
CARBON DIOXIDE RELEASE BY PLANTS

Materials for groups of three:

1. Fermentation tube
2. Yeast suspension
3. Sugar solution
4. Bromthymol blue indicator
5. Flask (500 ml)
6. Graduated cylinder
7. Cotton

We know that the burning of fuels is a chemical reaction. This burning, whether it is a candle or food requires a starter. In our laboratory work we use a match as a starter. But what is the starter inside the bodies of living things? Some chemical reactions are controlled by special chemical starters called catalysts. Catalysts, when present in living things, are called enzymes. Enzymes start many of the reactions in living things. There are many different kinds of enzymes. Let us see what one such enzyme does.

Measure 100 ml of yeast suspension and pour it into a test tube. Add 10 ml of the sugar solution that has been prepared. Now pour this into a fermentation tube. Measure 106 ml of water and pour it into a clear flask. Add 10 ml of sugar solution. Now pour this into another fermentation tube. Place a piece of cotton into each fermentation tube. Label tube # 1 with yeast, tube # 2 without yeast. Now place the tubes in a warm, dark place overnight.



Student
page 2

Now take the fermentation tubes out and record what you see.

1. What difference do you see in the level of the solution in both tubes?
2. In which tube do you see the accumulation of gas?
3. What do you think this gas is?

Remove the cotton from both fermentation tubes. Add about 5 ml of Bromthymol blue to each tube. Shake carefully.

4. Is there a color change in tube # 1?
5. Is there a color change in tube # 2?
6. What does the color change indicate?
7. What was the fuel for this chemical reaction?
8. In which tubes did a burning of fuel take place?
9. What things are necessary for this chemical reaction?

TEACHER DIRECTION B - 36

DO PLANTS NEED FOOD?

Materials for groups of three:

1. 8 oz. wide mouth bottles
2. 2-small bowls or pans
3. 2-gummed labels
4. 1-test tube
5. 2-glass squares
6. Corn syrup
7. Bromthymol blue
8. 2-250 cc beakers
9. Alcohol burner
10. Package dry yeast

Most students will not consider yeast as a plant, the point should be emphasised that not all plants are green. Yeast is an example of a non-green plant since it contains no chlorophyll. Plants without chlorophyll must get their food from an outside source. Plants without chlorophyll of necessity will be either parasites, (living on live material) or saprophytes (living on non-living material.) In this activity the food source is sugar via the corn syrup. The yeast plants will give off waste products as all living organisms must do. In this case carbon dioxide a gas and alcohol a liquid are the wastes. (pass out B-36) Give each student a small sample of dry yeast to examine with the hand lens.

LOOK AT THE YEAST YOU HAVE--WHAT COLOR IS IT? (brown) DOES IT CONTAIN ANY CHLOROPHYLL? (no) HOW DO YOU KNOW? IS IT A PLANT? ARE THERE ANY OTHER PLANTS THAT ARE NOT GREEN? (mushrooms, etc.) IF IT DOES NOT CONTAIN CHLOROPHYLL HOW DOES IT GET ITS FOOD? (from its environment) IN THIS ACTIVITY YOU WILL FIND OUT IF IT NEEDS FOOD AND HOW THIS FOOD IS CHANGED BY THE YEAST PLANT.

NOW LETS GET STARTED ON THIS ACTIVITY.

Teacher Direction
page 2

After students have set up the activity have them reassemble to discuss exactly what was added to each tube, and why. Ask them what results they expect in each tube, and why?

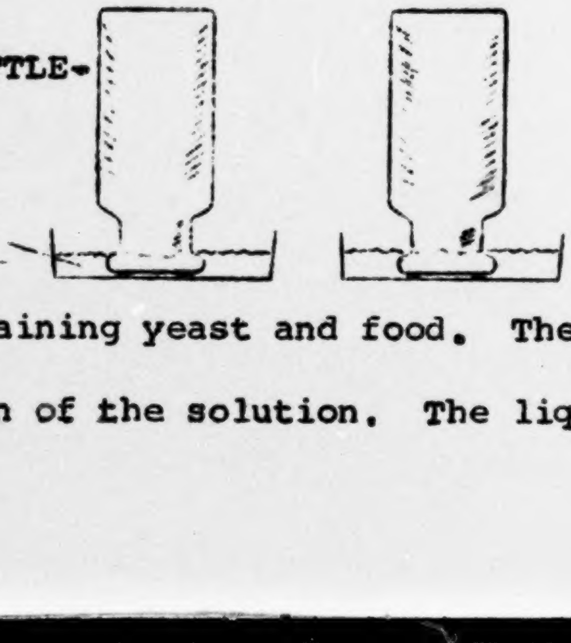
The yeast solution should be prepared and placed on the front desk for students to use as the need arises.

DO PLANTS NEED FOOD?

Materials for groups of three:

1. 8 oz wide mouth bottle
2. Small pans
3. Gummed labels
4. Test tube
5. Corn syrup
6. Bromthymol blue
7. Two beakers, 250 cc
8. Alcohol burner
9. Yeast
10. Glass plates

Did you know that yeast consists of many tiny living plants. The following experiment is to see if yeast plants need food as other living organisms do. Heat about a quart of water in a suitable container. Take two wide mouth bottles label one bottle, Number 1, Yeast plus food. Label the other bottle, Number 2 Yeast without food. Add two teaspoons full of corn syrup to bottle Number 1 then fill the remainder of the bottle with yeast solution on the front desk. Fill bottle Number 2 with yeast solution only. DO NOT ADD ANY SYRUP TO BOTTLE Number 2. Fill the two small pans about half full of warm water. Place a small glass square over the mouth of the bottles. Take care that no liquid is lost from either bottle. Invert the bottles in the pans and place them in a warm place until the following day and then examine the results.



Look at bottle Number 1, containing yeast and food. The yeast plants have caused the fermentation of the solution. The liquid has been forced out of the bottle. Slip the glass plate under the mouth of the bottle. Remove it from the pan and set it upright on the table. Test the gas in the bottle by pouring it into the test tube containing clear limewater. Shake the contents. The limewater should change to a milk color, showing that the gas is carbon dioxide. Smell the liquid in the pan. Does it have an odor? Some of the syrup has been changed by the yeast plants into alcohol.

Now look at bottle Number 2, the bottle containing the yeast without food. Has any change taken place?

1. What is the name of the plant in this bottle?
2. What did the plant use as food?
3. Why did the plant not produce its own food?
4. Were there any waste materials given off by the yeast? If so, what?
4. How can you explain the results in bottle number 2?

The experiment shows that yeast plants need food just as other living organisms do. Their food, as shown by bottle Number 1, consists of sugars and syrups. During the process of fermentation, the sugar is changed to alcohol. The chemical equation for this change is as follows:

$$\text{Grape sugar} + \text{Yeast} \longrightarrow \text{Carbon Dioxide} + \text{Alcohol}$$

$$C_6H_{12}O_6 + \text{Yeast} \longrightarrow 2\ CO_2 + 2\ C_2H_5OH$$

TEACHER DIRECTION B - 37

FOOD TESTS FOR SIMPLE SUGARS

Materials for groups of three:

1. One large test tube
2. One alcohol burner
3. One large onion
4. Benedict's solution
5. Test tube holder

Students not familiar with the test solution may get the idea that the solution will change color if heated without the sugar products. You may disprove this by heating some Benedict solution without anything added. This would be an excellent opportunity to demonstrate the proper procedure for heating liquids in a test tube. You may wish to have a large beaker of boiling water for students to heat the solution in.

Pass out B-37

SINCE ALL GREEN PLANTS CONTAIN CHLOROPHYLL THEY CAN PRODUCE THEIR OWN FOOD IN THE FORM OF SUGAR. WE CAN TEST FOR CERTAIN SUGARS USING BENEDICT SOLUTION. DO YOU THINK AN ONION HAS SUGAR IN IT. WHY? LETS FIND OUT.

FOOD TESTS FOR SIMPLE SUGARS

Materials for groups of three:

1. One large test tube
2. One alcohol burner
3. One large onion
4. Benedict's solution
5. Test tube holder
6. Other foods, Cane sugar, lettuce, celery, bananas

We know that one of the final products of photosynthesis is a chemical called glucose. This chemical is a simple sugar.

Since photosynthesis occurs in all green plants, we would expect this process to take place in onions. Do you think the part of the onion plant we eat contains sugar? We can perform a test to answer this question by using a chemical that will tell us if sugar is present. This chemical that we are going to use is called Benedict's solution. To make the test, the benedict's solution must be heated.

Take a small piece of onion and chop it up into several small pieces and place these into a large test tube. Add enough Benedict's solution to fill the test tube to about ¼ its total volume. Then, using test tube holders place the test tube over the alcohol burner, being careful to point the test tube away from any of the members of the class. Whenever any material is heated in a test tube always follow this precaution, to keep the boiling liquid from burning anyone. Pass the test tube back and forth through the flame as you heat the mixture. Your instructor may have you place the tube in a beaker of boiling water to heat the contents. If sugar is present it will change from a blue color to a green color and eventually to an orange red color.

You may now test other plant materials for their sugar content, for example: bananas, celery, lettuce, grass, leaves, etc.

NOW LET'S RECORD OUR RESULTS.

1. What is the positive test for sugar?
2. Does this test work with cane sugar (sucrose=table sugar)
3. Do you think there are different kinds of sugars?
4. What difference would there be in the test results between a plant that has a large amount of sugar and one that has a small amount of sugar?
5. If you heat Benedict's solution alone, will it change color?
6. What does this prove?

TEACHER DIRECTION B - 38

PROTEINS

Materials for groups of three:

1. Hard-boiled egg
2. Nitric acid, concentrated
3. Test tube
4. Alcohol burner
5. Ammonium hydroxide

Since we have introduced the idea of foods and food test we shall pursue the idea further. The following test is a standard test for proteins. The chemical reaction will give a yellow color. It is important to remember that Nitric acid is DANGEROUS. Note: ALWAYS ADD ACID TO WATER WHEN DILUTING. Let the students hard boil the eggs the day before the activity or before class time. Make sure the eggs are hard-boiled by boiling them at least 15 minutes.

A PROTEIN IS A CHEMICAL SUBSTANCE THAT CAN BE USED FOR FOOD. THE LACK OF CERTAIN PROTEINS IN YOUR DIET WILL CAUSE DEATH. SO ALL LIVING ORGANISMS MUST HAVE PROTEIN. LET'S TEST FOR PROTEINS AND SEE IF AN EGG HAS PROTEINS PRESENT. LET'S GO OVER THE DIRECTIONS FOR B-38 TOGETHER. WE ARE GOING TO USE CONCENTRATED NITRIC ACID AND IT IS DANGEROUS. IF YOU GET ANY ON YOU, TELL ME IMMEDIATELY. YOU MUST USE EXTREME CAUTION. THE ACID WILL REMAIN ON THE INSTRUCTOR'S DESK AT ALL TIMES AND ONLY BE USED UNDER TEACHER DIRECTION.

Pass out B-38

Read the directions with the students. The term molecule will need to be defined. Use a very simple definition. Make sure they know what to expect. Two ml of nitric acid is to be added to some chips of egg white in a test tube and heat gently over an alcohol burner. It should turn yellow. To deepen the color, add a little ammonium hydroxide to the egg and watch the yellow turn to an orange color.

If the students get any of the acid on their skin, it will also turn yellow indicating they have proteins in their skin. Wash the hands in water with soap. The yellow spots will wear off eventually.

After the students complete the activity and clean up the laboratory, reassemble for group reports and a class discussion. Go over the material and answer any questions that may arise.

B-38

PROTEINS

MATERIALS FOR GROUPS OF THREE:

1. Hard boiled egg
2. Nitric acid, concentrated (HNO_3)
3. Test tube
4. Alcohol burner
5. Ammonium hydroxide (NH_4OH)
6. Other food containing proteins

The test for protein is a simple test. Proteins are large molecules that are found in every living organism. Organisms may have different amounts of proteins but they all have proteins. Scientists believe that the energy and the abilities of people are based on the proteins within their biological system. Certainly, much has been and is being done to investigate these relationships. It is certain, however, that the lack of certain proteins may cause illness or death.

The following test is just one of the many tests for proteins. If you are interested in other tests, a good book for reference is a SOURCEBOOK FOR BIOLOGICAL SCIENCE, by Evelyn Morholt, Paul F. Brandwein, and Alexander Joseph, published by Harcourt, Brace & World. Your library should contain this book. Look in the index under "Protein Test" to find the page number where the tests are located.

The following test is to be performed on the white of an egg that has been hard boiled. Remove several small pieces of the white and place them in a test tube. Then add a small quantity of nitric acid to the test tube. After adding the acid, light the alcohol burner and heat the contents of the tube very slowly by moving the test tube back and forth through the flame. Always remember to point the mouth of the test tube away from yourself and your partner. If proteins are present, a yellow color will appear on the albumin. After the yellow appears, let the test tube cool and add a little ammonium hydroxide.

A reaction may be written for this experiment:

Nitric acid + Protein ————→ Yellow color + Ammonium Hydroxide ————→ Orange color

When you have finished the experiment, answer the following questions:

1. Is protein present in the white of an egg?______________________________.

   How do you know?

2. Why is heat needed to cause the reaction of proteins and Nitric acid?

3. Do you think a chicken embryo could use some of the albumin for food?

   _____________________________. Why?

4. Do you think the white of an egg is good in your diet?__________________________

   Why?

TEACHER DIRECTION B - 39

CARBOHYDRATES

Materials for groups of three:

1. Test tube
2. Alcohol burner
3. Karo syrup
4. Piece of potato
5. Piece of bread
6. Benedict solution
7. Iodine (diluted with alcohol)
8. Scalpel

Carbohydrates, like proteins, are one of the chemicals used for food. Any well-balanced diet requires carbohydrates. The test for carbohydrates is very simple and very good results can be anticipated. The test is as follows:

SUGAR

Benedict's solution + Karo syrup (sugar) __________ copper color

STARCH

Iodine solution + Bread or potato (starch) _______ deep purple color

After the students have completed these tests they may wish to test other foods for carbohydrates. Allow them to do this if they use good laboratory procedure and report their findings.

A corn starch solution may also be used in place of the potato or the bread. Corn starch will be used later to show an enzyme reaction and it is suggested that the corn starch not be used at this time.

WHAT 3 FOODS HAVE WE TALKED ABOUT? (porteins, carbohydrates, and fats). WHAT IS THE TEST FOR PROTEINS? Discussion. Review test. LETS TEST FOR CARBOHYDRATES. CARBOHYDRATES ARE DIVIDED INTO TWO GROUPS, SUGARS AND STARCHES. BOTH ARE RICH SOURCES OF ENERGY.

There is a danger in the use of Iodine and Benedict's solution if taken internally. Permanent staining will occur if Iodine gets on clothes. Sometimes alcohol will prevent staining if applied liberally and immediately. Pass out B-39

Let the students read the directions and work independently. Circulate among the groups correcting techniques and asking questions.

Teacher Direction
Page 2

After the students complete the activity, reassemble for a class discussion. Go over the material and answer any questions that may arise.

TELL ME SOMETHING, WHAT WOULD HAPPEN IF YOU SPILLED IODINE ON YOUR SHIRT? (It would turn purple and prove starch was present). WHAT WOULD HAPPEN IF YOU SPILLED NITRIC ACID ON YOUR ARM? (It would turn yellow proving proteins were present).

The next test will be for fats. This test is not very dramatic, but extra time can be used wisely in reviewing previous tests.

STUDENT B - 39

CARBOHYDRATES

Materials for groups of three:

1. Test tube
2. Alcohol burner
3. Karo syrup (white)
4. Piece of potato
5. Piece of bread
6. Benedict's solution
7. Iodine solution
8. Scalpel

We are considering three basic food substances, called proteins, carbohydrates, and fats. We know how to test for proteins, so now lets consider a test for carbohydrates. Carbohydrates are divided into two groups called sugar and starches. Lets consider each separately.

Test for Sugar

Obtain some Karo Syrup from your instructor in a test tube. Add an equal amount of Benedict's solution to the syrup and shake. Is there a reaction? Next heat the syrup and Benedict's solution over the alcohol burner by passing the test tube in and out of the flame very slowly. Remember to keep the test tube pointed away from yourself and your partners. You will see a very definite color change.

What color did the mixture turn?__________________

Was heat needed?____________ What does the heat do?________________________

____

What color is the Benedict's solution?____________ Do you believe copper is in the Benedict's solution?________________ Why? Record your results on the chart.

Test for Starch

To demonstrate the iodine test for starch, add a few drops of iodine to each of several test tubes prepared as follows: water only; water with corn starch; water with a piece of potato; water with white flour, water with sugar. Use small quantities of the material and heat each test tube to boiling. Note the blue-black color in the test tube containing starch. All kinds of starches produce a similar reaction with iodine: but chemists have found no other common substance that does so. We therefore take a blue-black color resulting from the addition of iodine to a substance to indicate the presence of starch. Record your results on the chart.

If you had toast, pancakes, and eggs for breakfast, would you have starch, sugar, and proteins?___________How do you know?

When you clean up your laboratory, make sure all of the iodine is removed from the table. If you cannot wipe it up, alcohol will remove it.

FOOD USED FOR TESTING	STARCH PRESENT	SUGAR PRESENT
1. Kayro Syrup		
2. Potato		
3. Bread		
4. Onion		
5.		
6.		

You may wish to test other foods. These results should be added to the chart.

TEACHER DIRECTION

B - 40

FATS

Materials for groups of three:

1. Olive oil
2. White paper towel
3. Test tube
4. Carbon tetrachloride (CCL_4)
5. hamburger meat
6. Eye dropper

This activity will show a simple test for fats. Many different types of fats can be used, mineral oil,fat meat, hamburger meat, lard, cooking oil, cooking grease, etc. The fat will leave a translucent spot on the paper towel that is readily observable when held up to the light. Water will also cause a translucent spot, but will not be permanent after drying. The student should be warned concerning this factor, and a drying period allowed. Using small quantities of the food samples will reduce drying time.

WE HAVE TESTED FOR TWO OF THE THREE FOODS WE HAVE TALKED ABOUT - PROTEINS AND CARBOHYDRATES. WHAT IS THE TEST FOR PROTEINS? (Discussion). WHAT IS THE TEST FOR SUGAR? (Discussion). WHAT IS THE TEST FOR STARCH? (Discussion) NOW, LETS TEST FOR FAT. THE TEST FOR FAT IS TO PUT AN UNKNOWN MATERIAL ON WHITE ABSORBANT PAPER AND ALLOW IT TO DRY. IF AFTER DRYING, A TRANSLUCENT SPOT REMAINS THROUGH WHICH YOU CAN SEE LIGHT PASSING, THEN FAT IS PRESENT. IF THE SPOT GOES AWAY WHEN IT IS DRY, THEN FAT IS NOT PRESENT. (Discussion)

Pass out B-40

There are really two tests. One is just placing olive oil on a paper towel, wait 10 minutes, then look at the spot. The second test is to use a solvent to remove the fat, carbon tetrachloride, and then testing the mixture. The carbon tetrachloride will evaporate leaving a translucent spot of fat on the paper. If carbon tetrachloride is used students must be cautioned to avoid enhaling any of the vapors which are poisonous.

YOU HAVE BEEN GIVEN THE ACTIVITY TO DETERMINE IF FAT IS PRESENT. THERE ARE TWO

TYPES OF FATS, SATURATED FATS WHICH ARE SOLID AND POLY-UNSATURATED FATS WHICH ARE OILS, OR LIQUIDS. (Discussion) YOU ARE TO TEST FOR BOTH. FOLLOW THE DIRECTIONS CLOSELY. (Discussion) Tell the students to read the directions and proceed to test for fats.

After the students complete the activity, reassemble for a class discussion. Discuss the results of the test for fats.

STUDENT

B - 40

FATS

Materials for groups of three:

1. Olive oil
2. White paper
3. Test tube
4. Hamburger meat
5. Carbon Tetrachloride
6. Eye dropper
7. Forceps

This is the final test for the three foods we are considering. Fats are really divided into two groups; the liquid oils which are called poly-unsaturated fats and the solids which are called saturated fats. Fat meat is a solid and is called a saturated fat. Olive oil is a liquid and is called poly-unsaturated fat. The only difference in the chemical content of saturated and unsaturated fats is the amount of hydrogen present. By the addition of hydrogen , unsaturated fats become solids such as peanut butter and margarine. Many people are interested in saturated and unsaturated fats due to their possible connection with hear conditions.

First, you will find how to test for oils and fats by placing some olive oil on a piece of white paper. It forms a translucent spot through which light readily passes. If the olive oil contains water, a waiting period will have to be observed for the water to evaporate.

Number the corners of the paper from one to four. In the corner numbered one, place one drop of olive oil. In the corner number two, place a drop of water. After placing the drops on the paper towel, lay the towel down on the table, unfolded, and with the numbers up. This is to allow the water to evaporate.

While you are waiting for the water to evaporate you can begin the second test for a saturated fat. Place a small piece of hamburger meat in a test tube. Add ten drops of carbon tetrachloride. Remove the hamburger from the test tube with your forceps. Pour a few drops of the remaining liquid on the paper in corner number three.

Test peanut butter or crushed peanuts for fats in the same manner, and place the liquid on corner number four.

All of the corners of the paper should have a drop of something on them. If fat is present, a translucent spot can be readily seen when you hold the paper up to the light.

Do you have fat in the following places?

TEST FOR FATS

Corner Number One (Olive Oil)	Corner Number Two (Water)	Corner Number Three (Hamburger)	Corner Number Four (Peanut)
Yes No	Yes No	Yes No	Yes No
How do you tell:	How do you tell:	How do you tell:	How do you tell:

Indicate in the table below how you can test a food substance like the white of an egg for the presence of protein, fat, sugar, and starch.

FOOD SUBSTANCE	TEST MATERIALS	WHAT TO DO	RESULTS IF PRESENT
Protein			
Fat			
Starch			
Sugar (Karo)			

TEACHER DIRECTION

B - 41

BUILDING A CALORIMETER

Materials for groups of three:

1. Small tin can 2. Cork 3. Pin

The term calorie is widely used, but few understand its importance. People on diets are generally "calorie counters" and use this as a basis for determining what to eat. This activity will show some of the aspects and measurements of calories. Technically a calorie is the amount of heat required to raise the temperature of one gram of water one degree centigrade. A large calorie is the amount of heat required to raise the temperature of a liter of water one degree centigrade. Diets are measured in large Calories. An adult needs from 2000 to 3000 Calories per day. Both units are measures of heat energy. 1 C = 1000 c. This activity is not very accurate due to heat loss to the atmosphere, but the idea of heat energy and heat content can be shown.

The students should bring in small juice cans the day before you begin this activity. This procedure requires that the students cut an upside-down "v" in the side of the can that has one end cut out. The size of the "v" should be large enough to slide a cork in and out of the can without touching the side. A hole should be cut in the top of the can the size of a test tube. Then small air holes should be randomly made in the top of the can with a nail.

The students will measure the calories of heat energy released when small samples of food are burned beneath a test tube containing 10 grams (milliliters) of water.

The transparency will be useful in demonstrating the procedure. This activity will only be concerned with the preparation of the can to be used as a calorimeter. BSCS Patterns and Processes is a very good reference for students as well as teachers. The can must have air holes at the top or burning of the nuts will not be complete. The triangle at the bottom serves two purposes, to allow an air draft and ease of inserting the cork and burning nut. If the nut does not burn until charred, it is an indication that the air draft is not sufficient.

WE HAVE TALKED AT LENGTH CONCERNING HEAT AND FOOD. THE HEAT OF THE BODY AND THE CHEMICAL REACTIONS THAT TAKE PLACE ARE VITAL IN MAINTAINING LIFE. SCIENTISTS USE A TERM TO EXPLAIN THE FOOD AND HEAT RELATIONSHIP. IT IS CALLED A CALORIE. HOW MANY OF YOU HAVE HEARD OF THE WORD CALORIE? The students have heard of low calorie food like Metracal, Sego, etc. Low calorie bottled drinks are also on the market such as Tab, Fresca, etc. Alcoholic beverages are high in calories. HOW DO YOU SUPPOSE SCIENTISTS DETERMINE HOW MANY CALORIES ARE IN DIFFERENT KINDS OF FOODS? Do not expect students to know the answer. Heat energy is the key concept to be concerned with regarding calories. SCIENTISTS DEFINE A CALORIE AS THE AMOUNT OF HEAT REQUIRED TO RAISE THE TEMPERATURE OF ONE GRAM OF WATER ONE DEGREE CENTIGRADE. THESE CALORIE UNITS ARE JUST 1/1000 THE SIZE OF THE FOOD CALORIES USED IN MEASURING HUMAN DIETS. (Discussion). One gram of water occupies a volume of one milliliter. HOW WOULD YOU MEASURE OR "COUNT" CALORIES? Discussion. WHAT MATERIALS WOULD YOU NEED TO CARRY OUT THIS EXPERIMENT? Thermometer, test tube, heat emitted from the material in question, and water. OUR NEXT ACTIVITY IS A WAY TO MEASURE CALORIES. WE ARE GOING TO USE TIN CANS, TEST TUBES, AND CORKS TO MEASURE THE CALORIES IN A PECAN AND A PEANUT.

Pass out B-41

THIS ACTIVITY IS DIVIDED INTO TWO PARTS: PREPARING THE CAN TO BE USED AS A CALORIMETER, AND THEN ACTUALLY DETERMINING THE CALORIES BY RECORDING TEMPERATURE CHANGES IN WATER. IT IS IMPORTANT THAT WE FOLLOW DIRECTIONS ACCURATELY.

Place the transparency on the overhead projector. It will be important to explain each step to the students. The preparation of the can is required to prevent excessive loss of heat. A needle is pushed through a cork with the point extending above the top of the cork as shown on the acetate. A small piece of a nut, approximately 1/4 of 1/2 of the meat of the nut, is placed on the needle point. The nut is to be ignited with a match and placed under the can through the "v" shaped opening. The hole cut in the top of the can should be the size of the test tube. A good way to make this opening is to cut an "x" in the top, then push the test tube through the opening until it is about 1/4 inch above the nut on the cork. The steps to follow are:

1. Cut out one end of the can.
2. Cut a "v" out of the side of the can large enough for the cork and nut to pass through.
3. Push a pin and needle through a cork.
4. Cut an "x" in top of the can and insert the test tube.
5. Punch several holes at random in top of the can with a sharp object.
6. Have students mark cans so they can be easily identified.

Leave the transparency on the overhead projector while the students prepare their cans. Explain the terms calorimeter and milliliter but do not go into great detail. (See Unit I). An understanding will be obtained through the use of the calorimeter and the graduated cylinder. Check the preparation of each can.

After completion of the cans, store them for the next day. Students should put their name on the can for easy identification.

STUDENT

B - 41

BUILDING A CALORIMETER

Materials for groups of three:

1. Small tin can
2. 1 straight pin or needle
3. Aluminum foil
4. 1 cork
5. nail
6. Masking tape

Your tin can will serve a very good purpose in determining the amount of calories in a peanut and a pecan. Before you can determine the calories you must prepare the can. In this activity you are to prepare the can to be used as a calorimeter and then determine the calories in the next experiment.

A transparency will give you a diagram to go by. Follow directions very closely and do not get cut by the sharp edge.

It is important that you plan exactly what you are going to do in this activity. You are trying to find out how much heat energy is given off by a pecan and a peanut when it is burned. The tin can will help trap this heat energy and the water to be placed in the test tube will absorb the heat. The amount of absorbed heat then can be measured by the thermometer. It will be important to ignite the nuts with a match then very quickly push the nut under the can. After the nut has burned completely record the increase in temperature of the water on the chart. Repeat the process to get three different readings.

Questions of importance are:

1. Is the "v" cut in the bottom of the can large enough for the cork to pass through easily by sliding the cork?
2. Is the bottom cut out of the can?
3. Does the test tube fit tightly into the top of the can?
4. Is the test tube about 1/4-1/2 inche above the point of the needle?
5. Are there enough holes in the top of the can?
6. How much is 10 ml of water?

TEACHER DIRECTION

B - 42

CALORIE COUNTER

Materials for groups of three:

1. Calorimeter and cork
2. 1/4 pecan
3. 1/4 peanut
4. Thermometer
5. Matches
6. Test tube
7. Graduated cylinder

TODAY WE WILL DETERMINE THE CALORIES IN A PEANUT AND IN A PECAN. REMEMBER THAT A CALORIE IS THE AMOUNT OF HEAT REQUIRED TO RAISE THE TEMPERATURE OF ONE GRAM OF WATER ONE DEGREE CENTIGRADE. WE SHALL MEASURE THE HEAT ENERGY IN SMALL CALORIES. IT WOULD TAKE 1,000 OF THESE CALORIES TO EQUAL ONE CALORIE USED IN PLANNING HUMAN DIETS. READ THE DIRECTIONS CAREFULLY. BEFORE YOU BEGIN, LETS CONSIDER SOME OF THE IMPORTANT ASPECTS OF THIS ACTIVITY. THE STEPS TO FOLLOW ARE:

1. MAKE SURE YOU HAVE YOUR CAN AND THE CORK YOU ASSEMBLED YESTERDAY.
2. MAKE SURE YOUR TEST TUBE IS 1/4-1/2 INCH ABOVE THE POINT OF THE PIN.
3. MAKE SURE THE NUT IS ATTACHED TO THE POINT OF THE PIN SECURELY BEFORE IGNITING.
4. RECORD THE TEMPERATURE OF THE WATER BEFORE IGNITING THE NUT.
5. MEASURE TEN MILLILITERS OF WATER AND POUR IT INTO THE TEST TUBE BEFORE TAKING THE TEMPERATURE OF THE WATER.

YOUR ACTIVITY DIRECTIONS GIVE YOU STEP BY STEP DIRECTIONS. FOLLOW THEM VERY CLOSELY AND RECORD THE DATA REQUESTED.

Pass out B-42.

After completion of the activity reassemble for a class discussion.

At this point it will be necessary to attempt to tie all of the material together. The following activities will consider digestion and it is important that a good understanding of heat, protein, fats, and carbohydrates be exhibited by the students. The immediate problem of discussing calories should lead into the understanding of digestion. The chemical reactions of biology are the sources of heat and are therefore directly related to the chemical substances of proteins, carbohydrates, and fats.

Use the prepared transparency (B-42) and discuss the findings. There will be variations in the results. This will be obvious in the discussion. Explain these variations through class discussion of the procedure. If an extremely high reading is reported, it will probably be due to the cork catching on fire or reading the wrong scale on the thermometer. Some of the reasons for the wide variation in results will be:

1. Loss of heat through the tin can.
2. Loss of heat while lighting the nut before it is placed in the can.
3. Inaccuracy in reading the thermometer (must be centigrade).
4. Inaccuracy in measuring the quantity of water.
5. Cork catching on fire
6. The number of holes in the can permits the heat to escape too rapidly.
7. Nut going out before completely burned.
8. Not using same size piece of nut.

After discussing these aspects, discuss the idea that the body develops heat energy by chemical processes and therefore maintains its temperature of 98.6 degrees F, which is most favorable for maintaining the proper chemical activity for life.

Teacher Direction
Page 3

COUNTING CALORIES

Amount of Water							
Amount of Temperature change							

Average Amount of Water____________________

Average Amount of Temperature Change____________________

Calories = Avg. Temp. Change x Amt. of Water

1 Egg White = 16 Calories

1 Egg Yolk = 61 Calories

1 Egg = 77 Calories

1 Cup Peanuts = 840 Calories

1 Cup Pecans = 740 Calories

Peanut Butter Sandwich = 350 Calories

Egg Sandwich = 285 Calories

CALORIE COUNTING

Materials for groups of three:

1. Calorimeter and cork
2. ½ pecan
3. ½ peanut
4. Thermometer
5. Matches
6. Test tube
7. Graduated cylinder

Remember that a calorie is the amount of heat energy required to raise the temperature of one gram of water one degree centigrade.

Follow the directions very closely. After each step, record the data in the table if there is a space provided to write it.

1. Place the calorimeter upright, insert the test tube and adjust it so that the tube is ½ inch above the point of the pin.
2. Obtain 10 ml of water and pour it into the test tube.
3. Break the pecan into four pieces and place one piece on the needle.
4. Record the temperature of the water in the test tube.
5. Ignite the nut and immediately push it through the opening in the can directly under the test tube.
6. Record the temperature of the water immediately when the fire goes out.

Repeat these same steps for determining the calories in a peanut. Try to obtain a piece of the peanut the same size as the piece of pecan used the first time. Record the data in the table on the next page.

Student
Page 2

DATA SHEET

PECAN	PEANUT
Temperature of water before lighting the pecan____________________C	Temperature of water before lighting the peanut________________________C
Temperature of water after the pecan quits burning___________________C	Temperature of water after the peanut quits burning________________________C
Difference in temperature____________C	Difference in temperature____________C

Multiply the difference in temperature by 10 because there are 10 ml of water.

PECAN: Difference in temperature x 10 = ___________________Calories

PEANUT: Difference in temperature x 10 = ___________________Calories

Which nut has the most calories?____________________________________

How can you tell?

Did the water boil?____________________If it did, what effect would this have on your results?

Did the cork catch on fire?_______Would this effect your results?________________

How would this effect your results?

List several ways that you can make this activity more accurate.

TEACHER DIRECTION

B - 43

BEGINNING OF DIGESTION

Materials for groups of three:

1. Bread
2. Test tubes (2)
3. Iodine solution
4. Benedict solution
5. Corn starch solution (10%)
6. Alcohol burner

The first stage of digestion begins in the mouth. The chewing process serves two purposes: (1) to expose more surface areas of the food to saliva and (2) to aid in swallowing. The first enzyme reaction occurs with the contact of the saliva and the food. There is no need to stress enzymes or even introduce the term, but if mentioned they can be defined as chemicals that aid in digestion. The actual reactivity of enzymes is very important and very complicated. The test will demonstrate that food is changed in the digestive system by chemical reactions and this chemical reaction is supported by mechanical means such as chewing.

SCIENTISTS HAVE FOUND THAT CHEMICAL REACTIONS BEGIN IN THE MOUTH. IN THIS ACTIVITY YOU WILL FIND OUT WHAT HAPPENS IN THE MOUTH. WE HAVE PREPARED AN UNKNOWN SOLUTION (corn starch) THAT HAS ALREADY BEEN CHEWED UP AND READY TO SWALLOW. I WANT YOU TO FIND OUT WHAT HAPPENS AND TELL THE CLASS WHAT YOUR GROUP FINDS. IT WILL BE VERY IMPORTANT THAT YOU NOT TELL UNTIL WE RETURN TO THE CLASS DISCUSSION AFTER THE ACTIVITY. IF ANOTHER GROUP WANTS TO KNOW WHAT YOU FIND OUT, DO NOT TELL THEM. I WILL GIVE YOU TWO CLUES. FIRST, THE IODINE SOLUTION AND THE BENEDICT SOLUTION WILL BE THE ONLY CHEMICALS I WILL GIVE YOU, SO YOU KNOW YOU MUST TEST FOR SUGAR OR STARCH. SECONDLY, THE SALIVA MUST BE FURNISHED BY A MACHINE. Have the students begin as soon as possible after the clues. Attempt to be somewhat evasive in order to have the students approach the problem independently. Be very careful not to ignore the students to the extent of preventing them getting started. You may allow the students to step into the hall to collect the saliva if this seems advisable.

Teacher Direction
Page 2

Pass Out B-43

After the students complete the activity, reassemble for a class discussion. Using the overhead projector, develop the first stages of instruction. The corn starch is rich in starch and iodine will readily prove this. The students can spit into a test tube containing the starch solution and warm it a few minutes. Sugar will be formed, thus showing that starch is changed into sugar in the mouth and is therefore the first chemical reaction of digestion. By discussion have the students develop the following formula. If necessary, write the formula on an acetate for their discussion.

Starch + Chewing + Saliva → Sugar + Saliva

Some of the saliva is of course swallowed, but the remaining saliva can attack the next bite of food. Bread may also be used if the students wish to pursue the activity further.

STUDENT

B - 43

BEGINNING OF DIGESTION

Materials for groups of three.

1. 2 test tubes
2. Bendicts solution
3. Iodine solution
4. Bread
5. Unknown solution
6. Alcohol burner
7. Wax Pencil

When you eat, a very complicated process begins. Your strong teeth tear and mash the food into small pieces that make the food easy to swallow. Other things also take place. Your mouth contains saliva that completely bathes the food as you chew. Many years ago it was found that saliva is a chemical substance that acts in digestion. You are to find out what this important chemical reaction is between food and saliva. Your instructor will give you an unknown solution and you are to find out what happens when it comes into contact with saliva. Do not drink this solution, but use test tubes to test the reaction.

The activity will be in two parts. The first part is to determine if the solution is a starch or sugar solution. The second part is to determine what happens to the solution after you spit into the solution.

PART A

Fill both test tubes about half full of the unknown solution. Label the test tubes number 1 and 2.

Test the material in test tube number 1 for starch with iodine.

IS STARCH PRESENT?_____________

Test the material in test tube number 2 for sugar.

IS SUGAR PRESENT__________________

What is the unknown solution, starch or sugar?

Student
Page 2

Part B

After washing the test tubes very thoroughly, refill them about half full of the unknown solution. Label the test tubes 1 and 2. To both test tubes add an abundant amount of saliva and shake the test tubes vigorously for five minutes to mix the solutions very well. Warm the solution then:

Test the material in tube number 1 for starch.

IS STARCH PRESENT?__________

Test the material in tube number 2 for sugar.

IS SUGAR PRESENT?____________

The unknown solution has possibly changed. If so, what change took place?

Write a short paragraph explaining what you have observed.

Try to write a formula showing what has happened.

TEACHER DIRECTION

We have now come to the end of our third series of activities dealing with energy and its relation to living organism. Let us think back over some of the important ideas we have discovered.

1. Burning is a chemical reaction that requires heat, fuel, and oxygen. In this reaction, carbon-dioxide, light, water and additional heat are given off.
2. Photosynthesis is the reverse of this process in that it requires carbon dioxide, water and sunlight and gives off oxygen and sugar. Photosynthesis takes place in all green plants in the presence of sunlight.
3. Chlorophyll is an important part of the photosynthesis process and gives leaves their green color.
4. Materials enter or leave the cell by way of the cell membrane by a process known as diffusion.
5. Heat energy may be measured in units called calories. One calorie is the amount of heat required to raise the temperature of one milliliter of water one degree centigrade.
6. As fuels are burned in the body to produce energy, carbon dioxide is also produced. The more energy produced the more carbon dioxide given off.
7. Carbon dioxide is given off by plants that do not contain chlorophyll and by those that do contain chlorophyll when they are not carrying on photosynthesis.
8. We can test foods to find if they contain sugar, starch, proteins, fats, and also the number of calories in each.
9. The process of digestion begins in the mouth and is brought about by chemicals found in saliva.

DISCUS

Materials for Class of 30 in Groups of Three
Life Science

ITEM	QTY	COST
Supplies		
Candle, medium size, Each	12	.60
Cardboard, 2" x 2", Each	24	N/C
Cellophane tubing, dialysis, Foot	12	.60
Clips, paper, large, Box	12	3.00
Clips, paper, small, Box	24	2.40
Corn syrup, Bottle	1	.30
Cotton, roll, Box	1	.90
Eggs, brine shrimp, Pkg.	1	.50
Eggs, chicken, fertile, Dozen	5	5.00
Foil, aluminum, Roll	1	1.00
Forceps, Dozen	3	5.91
Frog, preserved, Dozen	1	5.50
Glue, white, small, 4 oz. Bottle	12	3.00
Ice, cubes, Pound	12	.60
Ink, various colored, Bottle	4	1.00
Labels, gummed, Box	1	.25
Lens, hand, 10 X	12	7.68
Litmus paper, blue, Vial	6	.90
Litmus paper, red, Vial	6	.90
Matches, wood, Box	1	.25
Paint, spray, large, Can	4	5.00
Paper, Ditto, 8½ x 11, Ream	1	.70

ITEM	QTY	COST
Supplies		
Paper, filter, 125 mm, Box	2	1.00
Pan, small, Each	12	6.00
Pencil, wax, Each	12	1.20
Pin, straight, Box	1	1.00
Pipe cleaner, green and white, 6", Each	120	5.00
Pneumatic trough, plastic, Each	12	44.92
PTC paper, Package	12	1.20
Razor blade, single edge, Each	12	1.20
Ruler, 6", metric, plastic, Each	12	2.40
Ruler, 12", 3 hole, plastic	36	3.60
Salt, table, Box	1	.20
Sand, fine, builders, Pound	6	.60
Scissors, pointed, 5", Each	12	2.81
Seeds, navy bean, Bag	1	.25
Seeds, pinto bean, Bag	1	.25
Seeds, tobacco, irridated, Set	1	3.50
Seeds, tobacco, non-irridated, Set	1	1.00
Spatula, spoon, Each	12	8.52
Spinach, frozen, Package	1	.25
Stopper, rubber, #3, 1 hole, Each	12	.60
Stopper, rubber, #6½, 2 hole, Each	12	.60
Stopper, rubber, #7, solid, Each	48	2.20
Straw, soda, Box	4	1.00
String, #6, Spool or Cone	1	1.00

ITEM	QTY	COST
Supplies		
Sugar, cube, Box	1	.50
Tape, masking 1", Roll	1	.30
Thermometer, dual scale, Each	12	13.20
Thistle top, Each	12	3.34
Tongs, Each	12	12.60
Tubing, rubber, 2' length, Each	12	2.20
Weights, metal, Each	12	1.44
Wire, large diameter, Foot	48	1.00
Wire, small diameter, 10" long, Each	24	.25
Wood, splints, Bundle	1	.85
Yeast, dry, Package	1	.15
GLASSWARE		
Beaker, 150 ml, Each	12	3.72
Beaker, 250 ml, Each	24	7.44
Beaker, 600 ml, Each	12	5.52
Bottle, collecting, Dozen	4	3.20
Bottle, specimen, 8 oz, Dozen	4	7.20
Culture tube, Each	24	1.20
Cylinder, graduated, 100 ml, Each	12	19.56
Dish, evaporating, Each	12	11.66
Dish, petri, 20 mm, Each	12	6.72
Flask, erlenmeyer, 250 ml, Each	24	9.84
Funnel, short stem, 75 mm, Each	12	8.04
Glass squares, 2" x 2", Dozen	4	2.60

ITEM	QTY	COST
Supplies		
Jars, baby food, Each	24	N/C
Jars, gallon, Each	24	N/C
Lamp, Alcohol, Each	12	5.40
Medicine dropper, Each	12	.60
Mortar and Pestle, Each	12	17.16
Slide, microscope	60	2.00
Stirring rod, Pound	1	.70
Test tube, 200 mm x 150 mm, Each	40	3.24
Tubing, Glass, 6 mm, Pound	2	1.40
CHEMICALS		
Alcohol, ethyl, Gallon	5	12.35
Acetone, Pint	1	.71
Acetic acid, Pint	1	.35
Ammonium hydroxide, Pint	1	1.70
Bromthymol blue, 100 ml, Bottle	1	1.30
Baking soda, Box	3	.45
Benedicts solution, Quart	1	1.60
Carbon tetrachloride, Gallon	1	2.75
Glucose, pint, Bottle	2	.70
Hydrochloric acid, 3N, Pint	1	1.89
Hydrogen Peroxide, 30%, Pint	1	1.78
Iodine, solution, 1N, Pint	1	2.00
Nitric acid, concentrated, Pint	1	2.37
Phenolphthalein, solution 1%, Pint	2	4.18

ITEM	QTY	COST
Supplies		
Rotenone, 5% Emulsifiable, ounce	8	N/C
Sodium hydroxide, 1N solution, 500 ml	1	1.70
Starch. solution, Quart	1	.35
OTHER		
Incubator. egg, 50 egg capacity, Each	1	29.00
Ring stand. w/ring & clamp, Each	12	48.00
Stethoscope, Each	12	48.00
Test tube support, 6 holes, Each	12	13.92
	TOTAL	$467.42